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Essays on Regional Responses to Globalization

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Essays on Regional Responses to Globalization

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Abstract of the Dissertation

Essays on Regional Responses to Globalization

This dissertation explores various regional responses to globalization. The first chapter studies how booming regions spread local windfall from a commodity boom in the world market to other regions. The second chapter explores price divergence in the rice markets as an impact of a binding import ban, a policy imposed to support farmers from facing import competition. Lastly, the third chapter shows how the proliferation of electronic media, an aspect of globalization, facilitates improvement in marketing technology in advertising tobacco products. I show that such improvement in reaching consumers and potential consumers increases the smoking participation of young adults.

Chapter 1 studies how regions respond to price shocks in the presence of internal migration. This paper examines Indonesia in the 2000s as it faced a commodity boom for palm oil, which became one of its main export commodities. I exploit the variation in the land shares and crop suitability to compute the potential contribution of main crops across district economies as a measure of local exposure to shocks. I find that the commodity boom increased the purchasing power of palm oil-producing districts. These districts also received more migration, providing evidence that palm oil price shocks were no longer localized. Indeed, internal migration spread the windfall. I also find spillover to neighboring districts. However, these relatively higher levels of purchasing power did not last after the commodity boom ended in 2014. I show that the palm-oil sector grew through extensification as a response to the price shocks, with no indication of growth through intensification. I estimate the overall welfare gains in Indonesia between 2005 and 2010 and find substantial gains from migration.

Chapter 2 explores and documents the price divergence that occurs due to a large and ongoing import ban on rice imposed by Indonesia. I find that despite the increase in the retail price of rice, rice-producing districts do not enjoy higher purchasing power. The trade protection did not spur growth in the rice sector either. I find that the import ban causes price divergence in two dimensions. First, it causes regional price divergence, implying the lack of arbitrage across rice markets. Second, I find evidence of incomplete pass-through as the wedge between the retail prices and farm-gate prices widens. These findings provide guidance for further research and trade policy evaluation to consider aspects such as imperfect competition and domestic trade frictions in determining the distributional impact of the import ban.

Chapter 3 is motivated by the fact that the tobacco epidemic kills more than 8 million people every year. Despite a global decline in smoking rates, smoking prevalence is rising in many developing countries. This paper exploits the temporal and regional variation in the proliferation of television reception across Indonesia in the 2000s to examine the impact of advertising on electronic media on smoking participation by young adults. Applying the marketing theory drawn from international trade, I find evidence of a new-consumer margin in tobacco consumption due to improvement in marketing technology. Living in a subdistrict with one standard deviation higher television exposure increases male young adults smoking participation by 4-6%. This impact is especially significant for those of 17 to 19 years old but not older persons.

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Chapter 1

Global prices and internal migration: Evidence from the palm oil boom in Indonesia

1.1 Introduction

Many developing economies are primary-commodities producers that face trade shocks from global price fluctuations. International macro literatures have shown that the impact of these fluctuations is not trivial. For example, Fernández et al. (2017) show that 30% of domestic output fluctuations are driven by world shocks that stem from commodity prices. In theory, labor market can respond directly to these fluctuations by moving to booming sector or regions. However, many empirical studies show that trade shocks are usually localized, i.e., labor does not response by moving. Meanwhile, Lucas (2015) documents that one out of ten people in the world is an internal migrant. In developing countries, the intensity of internal migration ranges from as low as 6% in India to as high as almost 50% in Chile. Therefore, understanding how labor responds through mobility in the face of price shocks in international trade is an important question for many developing countries.

The goal of this paper is to study how a multi-region economy responds to price shocks stemming from commodity prices in the presence of internal migration. I take the context of Indonesia as it faced a commodity boom in the 2000s. I fill the gap in the literature by providing evidence of trade shocks that are no longer localized, especially when these trade shocks are advantageous to local income. Many studies on the impact of trade shocks use import shocks that deteriorate income.[1] If there are fixed migration costs or cash-in-advance constraints in migration, then we may not see much response through migration in the face of trade shocks that hurt income. Specifically, I show that internal migration diffuses trade shocks stemming from the commodity boom as people move to palm oil-producing districts.

This paper also contributes to the development policy discourse. I show that the windfall from the commodity boom was short-lived. This paper is the first to document the impact of fluctuations in global prices on welfare indicators over time. It is important to emphasize that this temporary windfall stands in contrast to the longer-run cost imposed by the well-documented deforestation driven by palm oil expansion.[2] This evidence can inform policymakers, including local leaders who have substantial decision-making power over land concessions. The findings also suggest cautions about exchange rate management for the monetary authority, given the importance of primary commodities, including palm oil, as a source of foreign reserves.

Indonesia is an excellent context for studying the impact of price shocks in developing economies for at least three reasons. First, Indonesia is a large country, in terms of population, size and area, but it is mostly a price-taker in the world market. Thus, Indonesia shares with most developing economies the feature of being a small-open economy. Second, there is a wide heterogeneity in comparative advantage across regions in Indonesia. Hence, Indonesia provides the opportunity to study variation in the exposure to shocks in the face of uniform price shocks. Indeed, Indonesia's regionally representative data makes it possible to study the country as a multi-region economy. Third, there are no legal-restrictions on moving from one region to another in Indonesia. Regions do vary in terms of their level of amenities level, and people have heterogeneous preferences to live in certain regions. Nevertheless, it

[1] This observation is also supported by Pavcnik (2017) in her lecture in the Jackson Hole Symposium in 2017. Some important studies using import shocks include Dix-Carneiro and Kovak (2017) for trade liberalization in Brazil, Topalova (2010) in India and Autor et al. (2013) for the surge of imports from China to the US.

[2] Hansen et al. (2013) show that Indonesia experienced the world's largest increase in forest loss in 2000-2012. Meanwhile, Austin et al. (2019) show that palm oil plantation was the largest single driver of deforestation in Indonesia for the period from 2001 to 2016. Globally, commodity-driven deforestation has been rampant, accounting for an estimated 27% of the world's forest loss (Curtis et al., 2018).

is plausible to regard residential choices as market-driven choices.[3]

To answer the research question, I perform a set of empirical and quantitative analyses guided by a theoretical framework that matches the context of Indonesia from 2000 to 2015. In particular, I collect three stylized facts that motivate the environment of the model. First, I choose the agriculture sector as the sector of interest, because farmers can adjust crop choices as they face changes in crop prices.[4] Districts with high shares of the agriculture sector also tend to be poorer, which means that districts have different starts before the exposure to price shocks. Second, I choose palm oil and rice as the main crops of interest because they share around half of the agricultural land in Indonesia. Third, the gravity equation on migration flows reveals that regions face upward-sloping labor supply. This result implies that labor moves to regions with higher earnings.

Armed with the three stylized facts, I build two theoretical frameworks as the foundation for the empirical and quantitative analysis. First, I combine a two-sector Specific Factor Model with the multi-region economy as in Redding (2016). I show that the impact of price shocks on regional wages depends on the share of the sector that experiences the increase in relative price. This result guides the measurement of local shocks in the empirical analysis. Second, I decompose the welfare changes in the multi-region economy model as in Redding (2016) into gains from migration and gains from trade. This result guides the quantitative analysis in estimating the overall changes in welfare in Indonesia between 2005 to 2010.

Defining districts as unit of regions, I construct a measure of exposure to price shocks for palm oil and rice based on the result of the theoretical framework. I compute local exposure to shocks using the potential share of palm oil and rice in district economies. In particular, I exploit the variation in crop suitability and pre-shocks harvested area. Armed with the computed local shocks, I employ the difference-in-difference method to estimate the impact of

[3]According to Artuc et al. (2015), migration costs in Indonesia are close to the average migration costs in developing countries. As a comparison, migration cost is estimated to be 3.46 of annual wage in Indonesia, 5.06 in the Philippines, 3.77 in Korea, 2.75 in China, and 2.21 in the US.

[4]The commodity boom in the 2000s affected both the agriculture sector and the mining sector directly. To take into account the exposure of the commodity boom to the mining sector, I control for the shares of mining sector but do not focus on it.

exposure to palm oil price shocks on two main outcome variables: real expenditure per capita as the main proxy for welfare and net-inward migration rate for labor-mobility outcome. I study the impact of the exposure to price shocks on three margins: between exposed and non-exposed, heterogeneity in exposure and spillover to non-exposed districts. In addition, I discuss the mechanisms that drive the results. Specifically, I analyze the responses of factors of production, i.e., labor and land, toward the price shocks. Lastly, applying the framework of asymmetric location and labor mobility as in Redding (2016), I estimate the welfare changes in the Indonesian economy between 2005 and 2010. I decompose the welfare changes into gains from migration and gains from trade.

I present three main findings. First, districts exposed to palm oil shocks had significantly higher real expenditure per capita compared to the non-exposed ones. I find that labor responded to the incentives from higher real expenditure per capita in districts exposed to palm oil price shocks. Accordingly, these districts attracted more net-inward migration. Since I follow districts' performance over time, I find evidence that the impact of the shocks was temporary. As the commodity boom ended, the difference between exposed and non-exposed districts also dissipated.

In an analysis of the mechanisms that drive the result, I find that the growth in the palm oil sector was spurred by land expansion (extensification) and not by an increase in actual yield (intensification). Meanwhile, analyzing district premia using the two-step method introduced by Dix-Carneiro and Kovak (2017), I find results that contrast with their results for trade liberalization in Brazil. In this paper, I find that district premia are relatively equalized across districts. This result implies that frictions to labor mobility may not be significant enough to prevent any shocks from diffusing through internal migration. Indeed, as the palm oil sector grew through land expansion, they may have increased labor demand in palm oil-producing districts. This increase in labor demand materialized as higher real expenditure per capita and net-inward migration.

Second, I show evidence of spillovers. The nearest non-exposed districts to districts exposed to palm oil shocks also have significantly higher expenditure per capita and migration. This result presents evidence that the shocks are not fully localized. They have an indirect impact on non-exposed districts. As districts experience a boom, they demand more goods and services as well as labor from the surrounding districts.

Lastly, I estimate that there was a welfare gain of 0.39% in Indonesia between 2005 to 2010. Gains from migration account for one-third of these gains, or 36%. Meanwhile, gains from trade account for the other two-thirds, or 64%, of the gains.

This paper contributes to three strands of literature. First, I contribute to the broad literature on the impact of international trade on labor markets in domestic economies. There are two main channels through which the trade shocks materialize: the price channel and the quantity channel. In the former, trade shocks can stem from trade liberalization as in Topalova (2010) and Kovak (2013), world price changes as in Adão (2015), trade cost changes as in Donaldson (2018), or a combination, such as in Sotelo (2015).[5] I complement this literature by studying trade shocks through the price channel and their relationship with internal migration.[6] I contribute to this literature by showing evidence of how local labor markets adjust and diffuse trade shocks that are advantageous to local income through internal migration.

Second, I contribute to the literature on trade, internal migration and regional dynamics by showing that the impact of the commodity boom has been short-lived. I emphasize the need for caution in taking cyclical factors such as global prices as a sustainable source of growth for regional development. I show that districts with direct exposure to the commodity boom in palm oil received more net-inward migration at the peak of the boom. This

[5] Meanwhile, the quantity channel can stem from implied technological changes, as studied by Autor et al. (2013) for the case of surges of imports from China by the US and by Costa et al. (2016) for the demand and supply shocks faced by Brazil due to the technological shock in China.

[6] Recent papers show evidence of the importance of taking into account internal migration. For example, Tombe and Zhu (2019) quantify the welfare impacts of reduction in internal trade costs, international trade costs, and internal migration costs in China and show that most of the welfare gain stems from a reduction in internal migration costs instead of the more commonly credited reduction in international trade costs as China joined the WTO. Meanwhile, Pellegrina and Sotelo (2020) use the case of Brazil to show that internal migration can shape regions' and ultimately countries' comparative advantage.

mechanism allowed other districts to benefit through outmigration to the booming regions. However, as the global palm oil prices decreased after the boom, these palm-oil producing districts may no longer have provided such spillover to other districts. Meanwhile, using trade liberalization in Brazil, Dix-Carneiro and Kovak (2017) show that regions facing larger liberalization experienced increasingly lower growth in wages and employment. They show that a lack of internal migration and slow capital adjustment amplify the local effects of trade liberalization. Using the accession of China to the WTO, Fan (2019) shows the importance of taking into account internal migration when estimating the impact of trade liberalization on interregional inequality and wage inequality. Méndez-Chacón and Van Patten (2019) study the regional dynamics in Costa Rica due to foreign direct investment flows. They show that the ease of internal migration dampens a monopsonist's market power to push down local wages.

Lastly, this paper contributes to the literature on the palm-oil economy. Qaim et al. (2020) provide the most recent survey of literature on the impact of the palm oil boom. This present paper has much in common with Edwards' (2018) study of the impact of palm-oil expansion in Indonesia on local poverty and deforestation, but I am the first to show the cyclicality of the impact of global palm oil prices on the sub-national level. In particular, I show that districts exposed to the palm-oil boom experienced a temporary windfall.

The rest of the paper is structured as follows. I lay out the context of Indonesia during the commodity boom in the 2000s in Section 2. In the same section, I state three facts that motivate the choice of agriculture sector, the choice of crops and the importance of taking into account internal migration. Guided by these facts, I describe the theoretical frameworks that guide the empirical analysis and the quantitative simulation in Section 3. I describe the main data and the measurement of exposures to price shocks in Section 4. Armed with the computed exposure to shocks, I present and discuss the empirical evidence of the impact of the exposure to the price shocks in Section 5. In Section 6, I describe the quantitative results of welfare changes estimation. In Section 7, I present the conclusions that can be drawn from the analysis.

1.2 Indonesia in the 2000s

1.2.1 Overview

Indonesia is the biggest economy in Southeast Asia. It is the largest archipelagic state in the world, with more than 16 thousand islands[7], spanning over 3000 miles from the west to the east, i.e., approximately the distance from Seattle, Washington to Orlando, Florida. It is an emerging economy and also home to the fourth-largest population in the world, with more than 260 million people in 2018.

Indonesia is rich in natural resources. Such natural comparative advantages make Indonesia an important producer of primary commodities, including agricultural and mining commodities. The contributions of the agriculture sector and mining sector were around 10% and 7% of GDP from 2000 to 2010.[8] Despite the relatively small contribution to the size of the economy, the agriculture sector has the biggest contribution to employment in the economy. It accounted for 45% and 38% of employment in 2000 and 2010, respectively.[9]

At the end of the 1990s, Indonesia experienced a deep economic crisis as part of the Asian Financial Crisis (AFC). In the trough of the crisis in 1998, GDP growth plunged by -13%. The crisis propelled not only economic but also political reform. The economy took some time to benefit from the reform. It started to recover in 2000. Given the significant differences in economic and political institutions before and after the AFC, I take the start of the period of interest as 2000 or 2001.

In the second half of the 2000s, the Indonesian economy was characterized by high GDP growth fueled by high export growth. This period coincides with the commodity boom, i.e.,

[7]BPS (2019), "Statistical Yearbook of Indonesia 2019".

[8]Ibid.

[9]Calculated by the author from the tables of employment by sector and status on BPS' website: www.bps.go.id.

a period of high prices in the world commodity markets. Indonesia experienced double-digit export growth with an average of 12.9% in this period. As shown in Table 1, nominal and real expenditure per capita also grew by 15.8% and 7.4% between 2005 and 2010. I use the real expenditure per capita as proxy for the standard of living in this paper.[10] In general, various economic indicators indicate higher growth in the second half of the 2000s compared to the prior and subsequent periods.

Table 1 also shows statistics on recent migration in Indonesia. Recent migration is defined as changes of residence between the survey year and five years prior to the survey year.[11] Because I focus on internal migration, I include changes in residence at the district level and exclude international migration. The total recent migration ratio to the nation population may seem quite small, i.e., around 3-5%. However, as shown in Table 2, there is high variation in the prevalence of migration across districts. I use recent migration to show the responses of labor markets in terms of mobility.

1.2.2 The rising star of the commodity boom in the 2000s: Palm oil

The commodity boom began around 2003-2004 and reached its peak in 2011.[12] During the Global Financial Crisis of 2008 to 2009, commodity prices also plummeted but quickly rose again in 2010. Indonesia's main export commodities, such as palm oil, rubber and coal, follow this overall trend in the world commodity market.[13] To illustrate the extent of the boom for Indonesia as exporters, the world palm oil prices and rubber prices increased by

[10] The government also uses expenditure per capita as the indicator to measure poverty.

[11] I extract figures of recent migration from various rich micro data that capture the location of the respondents in the year of the survey relative to their residences five years prior. Hence, the recent migration figures here are flow variables.

[12] Fernández et al. (2020) show that the permanent component of the commodity boom peaked in 2008 or 2012 for emerging economies. Meanwhile, Fernández et al. (2017) shows the highest peak occurred in 2008, while the second highest peak occured in 2011. Fernández et al. (2018) estimate that the world-shock component reached its peak in 2008 and 2011. In the case of Indonesia, Sienaert et al. (2015) show that the peak for Indonesia's commodity basket occurred in February 2011.

[13] See Figure 1 for the trend of main price indices constructed by the IMF and Figure 2 for the trend in Indonesia's main commodities.

more than fourfold and ninefold at the peak of the boom compared to their levels in January 2000.

The extraordinary magnitude and length of the commodity boom provoked two key changes in Indonesia's export profile in that period. First, as shown in Table 1, exports grew faster than the GDP. Second, Indonesia's exports composition transformed during this period. Indonesia's main primary commodities for exports gained greater shares in Indonesia's export profile. Meanwhile, the shares of non-commodity exports, such as textiles and electronics, shrank as shown in Figure 3.

In addition, Figure 4 shows that most of the increase in exports of Indonesia's main export commodities, such as palm oil, was price-driven. For example, exports of palm oil increased fourfold in quantity but twelvefold in values between 2000 and 2010. This fact supports the assumption used in this paper that world price fluctuations in general and price shocks in the commodity boom period in particular are exogenous to Indonesia.

One may argue that as one of the biggest exporters of palm oil, Indonesia is not a price taker in the world market of palm oil.[14] However, various studies on the commodity boom show that the determinants of the boom are external factors in the perspective of Indonesian palm oil farmers. Such potential causes, as pointed out by Baffes and Haniotis (2010), include excess liquidity, fiscal expansion and lax monetary policy in many countries. Moreover, they argue that there is a strong link between energy commodity prices and non-energy commodity prices. Palm oil is used widely in both categories: in biofuel as an energy commodity as well as cooking oil and in numerous consumer goods as a non-energy commodity. Hence, it is plausible to treat Indonesia as a small-open economy in the world market for palm oil. In addition, exports have generally been greater than imports, making Indonesia a net exporter of palm oil. Thus, increases of palm oil price in the world market improve Indonesia's terms-of-trade.

[14] The main exporters of palm oil are Indonesia and Malaysia. Over the period of this study, Indonesia's market share increased from 26% in 2001 to 42% in 2011. Meanwhile, Malaysia's market share decreased from 57% in 2001 to 43% in 2011. In more recent years, Indonesia's market shares reached more than half of the world export market, while Malaysia's share was around one-third of the world export market.

1.2.3 Three stylized facts

I document three stylized facts that guide me in building the theoretical framework and running empirical exercises to identify the impacts of the price shocks from the commodity boom and import restrictions on Indonesian economy. The first fact guides me to understand the variation of the importance of the agriculture sector across districts. The second fact profiles rice and palm oil as the two main crops over the period of study, showing changes in their land shares and the importance of taking into account crop suitability. The third fact motivates the non-short run framework in the labor response, i.e., spatial labor mobility as a response to the varying degree of exposure to the commodity boom.

Fact 1: The agriculture sector had higher importance in districts that were poorer before the commodity boom.

Figure 5 compares the shares of the agriculture sector and the mining sector in districts' gross domestic products against their level of expenditure per capita in the period prior to the commodity boom and the import restriction on rice. Poorer districts, having a lower average expenditure per capita, tend to have a greater share of the agriculture sector. This fact is not surprising given the relatively small share of the agriculture sector's contribution to GDP compared to its large contribution to employment. Meanwhile, there is no clear pattern in the distribution of districts with a higher-importance mining sector among poorer or richer districts. In addition, the mining sector depends on natural endowments that are not as easily substituted as they are in the agriculture sector. Given the importance of the agriculture sector to the labor force in the economy, I focus on the exposure of price shocks in that sector. This fact also implies that there may exist some structural differences in less developed districts. In reduced-form analysis, I include several control variables to capture these potential structural differences.

Fact 2: Rice and palm oil became the two main crops.

Rice has the biggest share of agriculture land in Indonesia. It consistently takes at least one-third of the aggregate land for crops. One million hectares of rice agricultural land were added between 2000 to 2010, but rice's shares of the aggregate land decreased from 37% to 33%. Meanwhile, palm oil has grown to occupy the second-largest share of agricultural land. At the beginning of the boom, there were 2 million hectares of palm oil plantations. Over a decade later, palm oil has increased threefold to 6 million hectares. As a result, its share of land for crops increased from 6% to 14% from 2000 to 2010. In contrast, other main crops have not increased as much and hence decreased in terms of shares.

The substantial increase in the land share for palm oil occurred mostly in districts with high potential yield in producing palm oil. Comparing the ratio of palm oil plantations relative to each district's total area in 2001 and 2011 in Figure 7a, the increase in these shares tends to be larger where the potential yield is higher. Meanwhile, Figure 7b shows that land shares for rice have not increased as widely as those for palm oil. In contrast, some districts have reduced their shares for rice. This pattern goes hand-in-hand with the fact that there has been little increase in rice fields nationally, as shown in Table 3.[15]

The changes in crop mix and in particular the increase in land dedicated to palm oil as a booming crop may imply increases in labor demand in districts suitable for this crop. Figure 7a shows that suitability, represented by potential yield as estimated by FAO, also needs to be taken into account and that these yields are heterogeneous across districts.[16] Hence, in this study, I include changes in the prices of both palm oil and rice as price shocks. In addition, rice also faced exogenous price shocks stemming from import restrictions that started in 2004. McCulloch and Timmer (2008) provide a summary of the political economy of rice in Indonesia from the 1970s to 2008. Few changes in policy occurred between 2008

[15]One may wonder why there are districts with low suitability but a high land share for rice. The explanation is that rice is a staple food for most of the Indonesian population. People grow rice for their own household to eat. Also, because most farmers have a relatively low area of rice field per household, scaling up may not be easy.

[16]Another crop that could potentially be taken into account is rubber. However, FAO does not estimate the potential yield for rubber.

and the period of study of this paper.

Fact 3: Districts faced upward-sloping labor supply.

The period of high palm oil and rice prices did not only present large changes in prices but also it lasted for a relatively substantial period of time. This meant that some people had the opportunity to maximize their welfare by changing their residency. Table 4 shows the results of the running gravity equation on recent migration flows across districts from 2011 to 2014. This period captures internal migration during the high commodity prices period.

The result provides evidence that people move to districts that offer higher real expenditure per capita, or the preferred proxy for income in this paper. Specifically, the coefficient for real expenditure per capita in destination districts is positive and significant, implying that districts face upward-sloping labor supply. This result remains if we control for the estimated observed amenities level in both the destination and origin districts.

In order to see the variation of net-inward migration rates across regions, Table 5 above tabulates the net-inward migration rates by the percentiles of potential yield in growing palm oil and rice. Between 2000 and 2010, the median district increased its net-inward migration rates. Districts with high suitability for growing palm oil tend to have higher net-inward migration rates in 2010 compared to 2000. Meanwhile, districts with high suitability for growing rice tend to have lower net-inward migration rates in 2010 compared to 2000.[17]

1.3 Theoretical framework

The commodities or industries of interest in this study are crops. Data on employment from crops, unlike employment data in the manufacturing sector, is rarely available. Hence, we cannot use an exact measurement of exposure to shocks, such as in Topalova (2010), or a more general form as in Kovak (2013). Thus the first part of this theoretical framework provides a guide for measuring the exposure to price shocks and predicting how the shocks affect

[17] Both claims are true for the 70th, 80th, and 90th percentiles, but they are reversed for the top percentile.

wages across regions. Guided by the stylized facts presented above, I construct a theoretical framework that combines the classical specific factor model and the spatial economy set-up as in Redding (2016). This framework allows for the local labor market to face an upward-sloping labor supply. The main difference from Redding (2016) is that I assume a small-open economy that engages in trade with no iceberg trade cost, for both for international trade and interregional domestic trade. Meanwhile, labor can move across regions, taking into account asymmetric for preference on amenities in these regions.[18] In addition, I simplify the model by assuming a two-sector economy with each sector having a specific factor in its production function.

The second part of the theoretical framework uses the basic spatial model as in Redding (2016) with a continuum of goods instead of a two-sector economy in order to match the actual economy more realistically. In this part, I decompose the equation that shows the welfare changes into two parts: gains from migration and gains from trade. This simple decomposition guides the quantitative analysis in estimating the welfare changes in the period of the trade shocks.

1.3.1 Framework for measurement of exposure to price shocks: Two-sector economy

1.3.1.1 Environment

Consider a small-open economy consisting of N regions, indexed by $n \in N$. There are two sectors, indexed by $j = 1, 2$. The first sector is the non-commodity sector, labelled as sector 1. The second sector is the commodity sector, labelled as sector 2. Both sectors use labor as inputs and a specific factor. In this set-up, the non-commodity sector uses labor (L) and capital (K), while the commodity sector uses labor and land (T). The total endowment

[18] This setup implicitly assumes that migration frictions are more pronounced than trade frictions. Given that it is harder, for example, to find information on migration opportunities and there are fewer means to finance migration compared to trade, I take this assumption to be plausible enough.

of labor in the economy is fixed at the amount $\bar{L}$. Meanwhile, the goods produced by both sectors are homogeneous and are freely traded internationally and domestically in perfect competition markets. Let us denote the relative price of sector 2 relative to sector 1 as p_2.

Consumer Preferences The preferences of each worker ω are defined over consumption of goods produced by the non-commodity sector (C_1), the consumption on goods produced by the commodity sector (C_2), and the amenities provided by the region n, b_n, where she or he chooses to live:

$$U_n(\omega) = b_n(\omega) \left(\frac{C_1}{\sigma}\right)^{\sigma} \left(\frac{C_2}{1-\sigma}\right)^{1-\sigma}, \tag{1}$$

The elasticity of substitution between goods from sector 1 and sector 2 is α,with $0 < \sigma < 1$. As in Redding (2016), each worker ω takes an independent and idiosyncratic draw on amenities for each region n from the Fréchet distribution:

$$G_n(b) = e^{-B_n b^{-\epsilon}}, \tag{2}$$

where B_n, the scale parameter, determines the average amenities for region n while ϵ, the shape parameter, determines the dispersion of amenities across workers for each region. In this setup, the shape parameter is common to all regions. The higher ϵ, the less dispersed the distribution is.

Price Index Given preferences and the choice of the non-commodity sector 1 as the numeraire, the price index in region n is:

$$P_n = p_2^{1-\sigma}. \tag{3}$$

Note that the price index is the same in all regions due to the small-open economy assumption and the lack of trade costs. Hence we can further define $P \equiv P_n$ for all $n \in N$.

Production and Technology The production functions of both sectors are Cobb-Douglas using labor and the specific factor of each sector. The production function of the non-commodity sector in region n is the following:

$$Y_{n1} = \left(\frac{L_{n1}}{\alpha}\right)^{\alpha}\left(\frac{K_n}{1-\alpha}\right)^{1-\alpha}. \tag{4}$$

Meanwhile, the production function of the commodity sector in region n is:

$$Y_{n2} = \left(\frac{L_{n2}}{\beta}\right)^{\beta}\left(\frac{T_n}{1-\beta}\right)^{1-\beta}. \tag{5}$$

The labor demand for sector 1 in each region n is $L^D_{n1} = \frac{\alpha Y_{n1}}{w_n}$ for sector 1. Meanwhile, the labor demand for sector 2 in region n is $L^D_{n2} = \frac{\beta p_2 Y_{n2}}{w_n}$. Thus, the total labor demand in region n is the sum of the labor demand for each sector in the region, i.e:

$$L^D_n = \frac{\alpha Y_{n1} + \beta p_2 Y_{n2}}{w_n}. \tag{6}$$

Income Each worker is endowed with a unit of labor that he or she supplies inelastically. Each worker receives wages for the labor services he or she provides by working in region n. Moreover, I assume that the rent for capital and land in the whole economy is distributed in a lump sum to all the population. I use this assumption because the focus of this study is medium-run changes. In this regard, I do not take a stance on how non-labor inputs are endowed. Hence, for a worker in region n, her or his income equals:

$$v_n = w_n + \varphi, \tag{7}$$

where φ is the lump sum rental income from capital and land distributed to all of the country's population, or :

$$\varphi \equiv \frac{\sum_{n=1}^{N} r_{Kn} K_n}{\bar{L}} + \frac{\sum_{n=1}^{N} r_{Tn} T_n}{\bar{L}}.$$

Residential Choice Each worker maximizes her or his utility in (1) by taking into account her or his idiosyncratic preferences on amenities for each region. Using the properties of the Fréchet distribution, the probability that a worker chooses to live in region $n \in N$ is:

$$\frac{L_n}{\bar{L}} = \frac{B_n \left(\frac{v_n}{P_n}\right)^{\epsilon}}{\sum_{k=1}^{N} B_k \left(\frac{v_k}{P_k}\right)^{\epsilon}}. \tag{8}$$

This system of equations represents labor supply in each region $n \in N$. This system allows for an upward-sloping labor supply in which we can expect that a higher share of the population will choose to live in regions with relatively higher income and amenity levels. Since each worker supplies one unit of labor in her or his place of residence inelastically, the upward slope of the regional labor supply is determined only by migration.

Equilibrium Equilibrium in the economy is defined as $\{w_{n,} L_n, L_{n2}, r_{Kn}, r_{Tn}\}$ for each region $n \in N$, which solves the following system of equations:

$$p = w_n^{\beta-\alpha} r_{Tn}^{1-\beta} r_{Kn}^{\alpha-1}, \tag{9}$$

$$L_n = L_{n1} + L_{n2} \tag{10}$$

$$\frac{L_n^D}{\bar{L}} \equiv \frac{\frac{\alpha\left(\frac{L_{n1}}{\alpha}\right)^{\alpha}\left(\frac{K_n}{1-\alpha}\right)^{1-\alpha}}{w_n} + \frac{p_2\beta\left(\frac{L_{n2}}{\beta}\right)^{\beta}\left(\frac{T_n}{1-\beta}\right)^{1-\beta}}{w_n}}{\overline{L}} = \frac{B_n \left(\frac{v_n}{P_n}\right)^{\epsilon}}{\sum_{k=1}^{N} B_k \left(\frac{v_k}{P_k}\right)^{\epsilon}} \equiv \frac{L_n^S}{\bar{L}}, \tag{11}$$

$$p_2 = \left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha} \left(\frac{1-\beta}{\beta}\right)^{1-\beta} \frac{K_n^{1-\alpha}}{T_n^{1-\beta}} \frac{L_{n2}^{1-\beta}}{L_{n1}^{1-\alpha}}, \tag{12}$$

$$\sum_{n=1}^{N} L_n = \bar{L}. \tag{13}$$

1.3.1.2 Exogenous Price Shock

I will analyze the impact of exogeneous price shocks to wages in different regions. If labor has full labor mobility and homogeneous preferences across regions, wages across regions will equalize. Conversely, if regions as local labor markets have fixed amounts of labor, i.e., no labor mobility across regions, then the exogeneous price shock will be localized and the impact will be as predicted in the classic specific-factor model. That is, the exogeneous increase in price will be followed by an increase in wages of a lower percentage change.

Allowing for full labor mobility, but with heterogeneous preferences across regions, I provide a framework between the two extreme cases explained above. From the labor-supply side, each worker will consider all regions and maximize her or his expected utility. Meanwhile, since the regions may differ in their endowments of specific-factors in each sector, the exposure to the shock will vary across regions even though they all face uniform price shocks. This variation in exposure to shocks leads to variation in labor demand responses in each region. Hence, we can expect to see variation in the responses of wages in different regions from a universal price shock.

A Simple Case: $\alpha = \beta$

To derive the intuition above, consider a simple case in which the labor intensities in sector 1 and sector 2 are assumed to be equal, i.e., $\alpha = \beta$. Suppose there is an exogenous change in the relative price of sector 2. In order to see the changes in labor demand in region n, totally differentiate (6) and use the Envelope Theorem to obtain:

$$\hat{L_n^D} = \gamma_{n2}\hat{p_2} - \hat{w}, \tag{14}$$

where $\hat{x} \equiv {}^{dx}/_{x}$ and $\gamma_{n2} \equiv \frac{\alpha p_2 Y_{n2}}{\alpha(Y_{n1}+p_2 Y_{n2})}$, which is the share of sector 2 in the total output of region n.

Meanwhile, we totally differentiate (8) to see the changes in labor supply in region n:

$$\hat{L_n^S}\frac{L_n^S}{\bar{L}} = \epsilon B_n(w_n+\varphi)^{\epsilon-1}w_n\hat{w_n} - \left[\sum_{k=1}^{N}\frac{w_k\hat{w_k}}{\epsilon B_k(w_k+\varphi)^{\epsilon-1}}\right]. \tag{15}$$

Let us define $\hat{D} \equiv \sum_{k=1}^{N}\frac{w_k\hat{w_k}}{\epsilon B_k(w_k+\varphi)^{\epsilon-1}}$. Hence,

$$\hat{L_n^S}\frac{L_n^S}{\bar{L}} = \epsilon B_n(w_n+\varphi)^{\epsilon-1}w_n\hat{w_n} - \hat{D}. \tag{16}$$

Armed with the changes in labor demand in (14) and the changes in labor supply in (16), we can use the population-mobility condition in (13) to solve for the changes in wages due to changes in price. From the population mobility condition, we have:

$$\sum_{n=1}^{N}\hat{L_n^S}\frac{L_n^S}{\bar{L}} = 0. \tag{17}$$

Using 16, we can get:

$$\sum_{n=1}^{N}\left[\theta_n\hat{w_n} - \hat{D}\right]\frac{L_n^S}{\bar{L}} = 0 \tag{18}$$

$$\Leftrightarrow \hat{D} = \sum_{n=1}^{N}\theta_n\frac{L_n^S}{\bar{L}}\hat{w_n} \tag{19}$$

where $\theta_n \equiv \epsilon B_n(w_n+\varphi)^{\epsilon-1}w_n$.

Furthermore, using the labor-market clearing condition in each region $n \in N$ from (11), we have $\hat{L_n^D} = \hat{L_n^S}$, thus

$$\Leftrightarrow \hat{w_n} = \left(\frac{\lambda_n}{\lambda_n+\theta_n}\right)\left[\gamma_{n2}\hat{p} + \frac{\hat{D}}{\lambda_n}\right] \tag{20}$$

where $\lambda_n \equiv \frac{L_n}{\bar{L}}$.

Proposition 1. *For a given change in the relative price, $\hat{p}$, the impact on wages between region n and m is*

$$\frac{\lambda_n}{\lambda_n + \theta_n}\gamma_{n2} > \frac{\lambda_m}{\lambda_m + \theta_m}\gamma_{m2} \Rightarrow \hat{w_n} > \hat{w_m},$$

where $\lambda_n \equiv \frac{L_n}{\overline{L}}$ *as labor shares in region n,* $\theta_n \equiv \epsilon B_n(w_n + \varphi)^{\epsilon-1}w_n$ *represents relative amenities and initial wages,* $\gamma_{n2} \equiv \frac{\alpha p_2 Y_{n2}}{\alpha(Y_{n1}+p_2Y_{n2})}$ *as the share of the sector experiencing the increase of the relative price in the economy of region n.*

Proposition 1 shows that in the presence of a uniform price shock, the impacts on wages across regions vary. The changes in wages in each region depend on the region's share of the population, amenity level, and sectoral composition. Intuitively, an increase in the relative price of sector 2, the commodity sector, increases the demand for labor in sector 2. This mechanism allows a uniform price shock to be exposed to regions differently because each region has different sectoral composition. Meanwhile, the increase in the demand for labor in sector 2 in each region pushes up the wages in the region, which simultaneously attracts workers to move to the region with the booming sector. The movement of workers, then, effects changes in wages as more workers move to the region and increase the labor supply. This is when the upward supply of labor kicks in. The magnitude of changes in wages then depends also on labor share and amenity level, as these two factors affect labor supply. A region with a higher amenity level attracts more workers or retains more workers. Thus, for a given price shock and sectoral composition, the higher the amenity level of a region, the less price shocks affect region's wages.

1.3.2 Decomposition of welfare changes: Multi-sector multi-region economy

The goal of the quantitative analysis is to estimate the welfare changes for the set of the whole economy. Thus, I use the general framework of Redding (2016) to guide the quantitative analysis. The main environment of the multi-region economy includes: preferences as in (1) over amenities provided by location of residence, a set of tradable goods with share

α and housing with share $1-\alpha$. Agents draw idiosyncratic amenities from the Fréchet distribution with shape parameter ϵ as in (2). Meanwhile, tradeable goods are produced in monopolistic competition with many firms. Each region has productivity drawn from the Fréchet distribution with shape parameter θ.

The welfare gains from trade in this setup are shown in Equation 21 below. The equation shows the proportional changes in the welfare of people living in region n when the economy changes from state 0 to state 1. The welfare gains depend on not only the changes in domestic trade shares, π_{nn}, but also the changes in population shares. The parameters include α as the share of tradeable goods and services, θ as the shape parameter of the distribution of productivity and ϵ as the shape parameter of the distribution of amenities across districts.

$$\frac{U_n^1}{U_n^0} = \frac{U^1}{U^0} = \left(\frac{\pi_{nn}^0}{\pi_{nn}^1}\right)^{\frac{\alpha}{\theta}} \left(\frac{L_n^0}{L_n^1}\right)^{\frac{1}{\epsilon}+(1-\alpha)} \tag{21}$$

1.3.3 Decomposition

Consider the formula for the welfare gains from trade shown in Equation 21. Take the relative changes for each region n, where $\hat{x} \equiv \frac{dx}{x}$.

$$\hat{\pi}_{nn} = \frac{\theta}{\alpha}\left[\left(\frac{1}{\epsilon} + (1-\alpha)\right)\hat{L_n}\right] - \frac{\theta}{\alpha}\hat{U} \tag{22}$$

Multiply by regional weights φ_n that sum up to 1, and sum over all region n. These regional weights are the share of expenditure by region n, i.e., $\varphi_n = \frac{w_n}{\sum_i w_i} = \frac{w_n}{E}$.

$$\sum_n \hat{\pi}_{nn}\varphi_n = \sum_n \left[\frac{\theta}{\alpha}\left(\frac{1}{\epsilon} + (1-\alpha)\right)\hat{L_n}\right]\varphi_n - \sum_n \frac{\theta}{\alpha}\hat{U}\varphi_n$$

Since the aggregate domestic trade share is the weighted sum of the regional trade shares,[19] i.e., $\hat{\pi} = \sum_n \hat{\pi}_{nn}\varphi_n$, hence the changes in the aggregate domestic trade shares, $\hat{\pi}$:

[19]The total expenditure of the economy is the sum of the regional expenditures, w_n.

$$\hat{\pi} = \sum_n \left[\frac{\theta}{\alpha} \left(\frac{1}{\epsilon} + (1-\alpha) \right) \hat{L_n} \right] \varphi_n - \sum_n \frac{\theta}{\alpha} \hat{U} \varphi_n$$

Since $\sum_n \varphi_n = 1$,

$$\frac{\theta}{\alpha} \hat{U} = \sum_n \left[\frac{\theta}{\alpha} \left(\frac{1}{\epsilon} + (1-\alpha) \right) \hat{L_n} \right] \varphi_n - \hat{\pi} \tag{23}$$

Meanwhile, with $\bar{L}$ as the total population of the whole economy, we also know that:

$$\sum_n L_n = \bar{L}$$

Take the total differentials and multiply by $\frac{L_n}{L_n} \bar{L}$:

$$\sum_n \hat{L}_n \frac{L_n}{\bar{L}} = \frac{d\bar{L}}{\bar{L}} \tag{24}$$

where $\frac{d\bar{L}}{\bar{L}}$ is the aggregate growth of the population. We can set it as zero if there is no population growth or generalize it as shown above.

To simplify, assume that there is no change in total labor endowment in the whole economy, i.e., $\frac{d\bar{L}}{\bar{L}} = 0$, and subtract Equation 23 from the right-hand side of Equation 24:

$$\sum_n w_n = E$$

We can also express it in terms of shares of regional expenditures as below.

$$\sum_n \frac{w_n}{E} = 1$$

$$\sum_n \varphi_n = 1$$

With domestic trade shares, π_{nn}, as how much region n buys from its own production relative to its total expenditures, the weighted sum of regional domestic trade shares using these regional expenditure shares is the aggregate domestic trade shares.

$$\sum_n \pi_{nn} \varphi_n = \sum_n \frac{x_{nn}}{w_n} \frac{w_n}{E} = \frac{1}{E} \sum_n x_{nn} = \pi$$

$$\hat{U} = \underbrace{\left(\frac{1}{\epsilon} + (1-\alpha)\right)\sum_n \hat{L}_n\left(\varphi_n - \frac{L_n}{\bar{L}}\right)}_{\text{gains from migration}} - \underbrace{\frac{\alpha}{\theta}\sum_n \hat{\pi}_{nn}\varphi_n}_{\text{gains from trade}} \tag{25}$$

Proposition 2. *Assumming there is no change in total labor endowment in the whole economy, i.e.,* $\frac{d\bar{L}}{\bar{L}} = 0$ *and using* φ_n *as the district's share of the national expenditure and* λ_n *as the district's population share, the welfare change can be decomposed as the following equation. The first term represents gains from migration, while the second term represents gains from trade.*

$$\hat{U} = \underbrace{\left(\frac{1}{\epsilon} + (1-\alpha)\right)\sum_n \hat{L}_n\left(\varphi_n - \lambda_n\right)}_{\textit{gains from migration}} - \underbrace{\frac{\alpha}{\theta}\sum_n \hat{\pi}_{nn}\varphi_n}_{\textit{gains from trade}} \tag{26}$$

Proposition 2 shows that the welfare gains have two components. The first is gains from migration. The intuition is straightforward. The economy gains if people move to richer districts, i.e., districts with higher expenditure shares, φ_n , compared to their population shares, λ_n. The second component is the changes in aggregate domestic trade shares. The economy also gains if the domestic trade share, π_{nn}, decreases.

1.4 Data and measurement of exposure to shocks

Armed with the guidance in measuring regional exposure to price shocks as shown by Proposition 1, I compute the exposure of price shocks of the two main crops: palm oil and rice. Modeling Indonesia as a multi-region small-open economy, I use districts as the unit of observation for regions. Districts are the second-level administrative unit in Indonesia.[20] The heads of districts, like members of parliament at the district level, are elected directly by residents of the districts every five years. Local governments have some income from local taxes but also receive transfers from the central government. In addition, the minimum wage

[20]Indonesia has a central government and two levels of local government. The first level of local government is the province level. The second level of local government is the district level. The central government has the sole authority on several subjects, including trade policy.

is set at the district level.[21] Over the course of the period studied here, there have been numerous district and province proliferations. I use the administrative district definition in 2000 to maintain the same set of districts over time: 321 districts.[22]

1.4.1 Data

I combine several sources of data that can capture the determinants of regional welfare and regional exposure to price shocks as guided by the theoretical framework. Indonesian datasets allow me to do this because they contain regionally representative data. Below, I describe the main variables and datasets I use.

Real expenditure per capita The main outcome variable is real expenditure per capita. I use expenditure per capita because in the case of Indonesia, data on expenditure has been better recorded than data on income. Expenditure can capture well-being better than labor income can, because we also want to take into account any income from land rent.[23] Furthermore, the households savings rate is relatively small. Vibrianti (2014) tabulates the Indonesian Family Life Survey (IFLS) 2007 and shows that only 26% of households have savings. Hence, household expenditure data is a good representation of income.[24]

I obtain data on household expenditure per capita from the Social and Economic Household Survey (*Susenas*) directly and the from the survey published in the World Bank's INDO DAPOER database computed from *Susenas*. I use several district averages of expenditure

[21]There is an exception for the capital city of Jakarta, which is granted autonomy up to the province level only. Hence, the minimum wage is set at the province level for Jakarta province.

[22]The complete set has 342 districts. In most empirical exercises, I use a panel of 321 districts. A lack of data availability is the reason the full dataset is not used.

[23]Deaton (1997) discusses the advantages of using expenditures to capture lifetime well-being. As summarized by Goldberg and Pavcnik (2007), these advantages include (1) conditional on whether agents can shift inter-temporal resources, current expenditure better captures lifetime well-being, (2) if there are fewer reporting problems for consumption data than income data, and (3) changes in relative prices affect consumers not only through income but also through the purchasing power of their current income.

[24]IFLS is nationally representative. Its survey sample represents 83% of the Indonesian population living in 13 out of 26 provinces. IFLS in 2007 was the fourth wave of the survey. Given the representation, it is fair to take the estimates of the households savings rate tabulated from IFLS as an upper bound for Indonesia. For more information on IFLS, see: RAND Corporation, https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS/study.html.

per capita. First, I use the total district average, which includes the whole sample for each district. I also extract district premia from the mincerian regression on expenditure per capita reported in *Susenas* as another outcome variable. Furthermore, in order to get real expenditure per capita, I deflate expenditure per capita with Indonesia's CPI obtained from BPS-Statistics Indonesia (*BPS*).

Recent migration I use recent migration as the outcome variable that represents labor mobility. Recent migration is defined as a change of residential location between the survey years and five years prior to the survey years. For the years 2011 to 2016, I extract data on migration flows across districts from *Susenas.* Meanwhile, for earlier years, I obtain migration flow data from a sample of the Population Census and Inter-Census Population Surveys provided by IPUMS. From the constructed matrix of migration flows, I compute the net migration rate for each district.

Crop data To estimate the potential production of each crop in each district, I use the agro-climatically attainable yield provided in the 5-grid level raster data for palm oil and rice from the FAO - GAEZ dataset. This estimated yield depends on climate, soil condition and rainfall, which are exogenous factors in the production of each crop. This variable is constructed using certain assumptions about climate, a long-term variable. Specifically, the estimated yield is a single measure that represents the period from 1960 to 1990. The use of a single-measure yield is reasonable beacuse farmers care more about long-run cycles than about high-frequency variables such as daily rainfall in non-horticulture crop mix decisions such as rice and palm oil. Furthermore, I choose assumptions about the most relevant use of technology for each crop. I then take the district average of the yield for each crop.

I obtain data for harvested areas by district and by crop from the Ministry of Agriculture's statistics website.[25] The data on harvested areas include all types of plantations, i.e., both large and small plantation holders. For the national aggregate crop area, I use the

[25]Data can be downloaded at the following link: https://aplikasi2.pertanian.go.id/bdsp/en/commodity.

FAO database. The total area for each district is obtained from the World Bank's INDO DAPOER.

Prices All data on prices are converted into rupiah. World palm oil price data is obtained from the IMF Commodity Price Series. These price series are in US dollars.To take into account the rupiah's depreciation over the same period, I calculate the rupiah prices using exchange rate data from the FRED Database. Because Indonesia's small-open economy, the rupiah prices are the relevant prices. Hence, the price shocks measured in this paper are inclusive of this depreciation. Meanwhile, the retail domestic rice price data by province is obtained from *BPS*. The rice price data is in Indonesian rupiah. For both crops, I deflate the nominal prices with Indonesia's CPI from the *BPS* to get real prices.

Ideally, one would use the farm-gate prices instead. For the case of palm oil, since Indonesia is a price taker in the world market, and if we assume that the trade costs faced by the producing districts do not vary over the period of interest, the changes in real-world prices suffice to represent the changes in prices received by palm oil farmers, as these trade costs cancel out. Meanwhile, for the case of rice, I assume that the pass-through margin and the trade costs that make up the wedges between provincial retail prices and farm gate prices do not vary over the period of interest. Hence, the changes in real provincial prices also represent the changes in real farm-gate prices faced by rice farmers.

1.4.2 Exposure to price shocks

As we learn from Fact 1 and Fact 2, districts vary in their comparative advantage in agricultural products, especially in growing palm oil and rice. Hence, districts are not uniformly exposed to the increase in crop prices. In order to embody this exposure heterogeneity, I construct a measure of exposure to price shocks for each district and crop based on Proposition 1.

First, to capture the price changes, it is useful to define the timeline that I am using.

I illustrate this timeline below. Figure 8 shows the trend in real palm oil prices and real rice prices as the basis for the timeline. I define the treatment period as the onset of the commodity boom for palm oil prices and as the import ban started to have an impact on rice prices. For palm oil prices, I take 2010 as the end of the treatment period, because prices started to decline in 2011 even though the average price was still quite high. Meanwhile, as we can see from the figure below, the real prices of rices have been fairly stagnant since 2011. Hence, I also take 2010 as the end of the treatment period for rice price shocks. The post-treatment period of interest, then, is the subsequent the three to five years after the treatment period, i.e., from 2011 to 2014 or longer when data is available.

I define the pre-treatment period price as the average price between January 2001 and December 2005. Meanwhile, I define the treatment period price as the average price of the period that starts in January 2006 and ends in December 2010. To measure price changes, I take the long difference in log between the treatment period and the pre-treatment period. Figure 7 illustrates this timeline.

Applying Proposition 1 in the theoretical framework, which states that the impact of exogeneous price changes on income depends on the output share of the sector whose price changes, I construct a measure of exposure to price shocks in palm oil and rice for each district, S_{id}. Equation 27 below shows the construction of this measure. The measure allows districts to be exposed differently to uniform price shocks. The price of palm oil is exogeneously determined in the world market. Hence, all districts in the sample face the same prices and price changes for palm oil. Meanwhile, the prices of rice clear at the provincial level. I assume that farmers in each district are price takers to these provincial rice prices. This assumption is plausible given the size of each farmer relative to the province aggregate.

$$S_{id} = \hat{p_i} \frac{Y_{id0}}{GDP_{d0}} = \hat{p_i} \frac{p_{i0} \cdot T_{id0} \cdot \psi_{id}}{GDP_{d0}} \tag{27}$$

Crop i refers to palm oil and rice. Meanwhile, the sub-index d represents districts. The price change of crop i, $\hat{p}_i$, is the long difference of the log price of crop i. The pre-treatment estimated production value of crop i in district d, Y_{di0}, is computed using the pre-treatment average price of crop i, p_{i0}; the pre-treatment harvested area of crop i in district d, T_{id0}; and the district-average potential yield of crop i in district d, ψ_{id}. Meanwhile, GDP_{d0} is the district GDP excluding the oil and gas sector in the pre-treatment period.

Variations across districts in the estimated production of palm oil and rice are determined by variation in harvested area in the pre-treatment period and variation in crop suitability from the FAO GAEZ data. In the pre-treatment period, there was no indication that farmers predicted that the commodity boom would occur. As Fact 2 suggests, even in districts that are very suitable for palm oil, the harvested areas were relatively low, similar to those in districts that are less suitable. Furthermore, the importance of each crop across districts is also determined by the size of the economy of the district. I use district GDP excluding the oil and gas sector, because I assume that this measure represents the pie of the economy that are distributed locally in each district.

Figure 9 and 10 display the computed exposures of palm oil price shocks and rice price shocks across districts. The districts with the highest exposure to palm oil price shocks are concentrated in Sumatra, the main island on the west end of the country, and Borneo, the main island east of Sumatra. Meanwhile, the districts with the highest exposure to rice price shocks are spread out across all of the main islands of Indonesia. Table 6 exhibits the summary statistics of the computed exposure to price shocks.

Defining exposed districts

I group districts into a set of exposed districts and a set of non-exposed districts for each crop. As we can observe from the distribution of exposure to shocks in Figure 9, Figure 10 and Table 6, more than half of the districts are not exposed to palm oil price shocks. Meanwhile, most districts have some degree of exposure to rice price shocks. The latter fact is not surprising because rice is the staple food for most of Indonesia's population. Many districts produce some amount of rice even if they are not net producers.

For palm oil, I define exposed districts as districts with positive values of exposure to shocks and non-exposed districts as those with zero exposure to palm oil price shocks. For rice, I define exposed districts as districts with an exposure value higher than the 40th percentile. The final set of these exposed and non-exposed districts is summarized in Table 7 and illustrated in Figures 11 and 12. Out of 321 districts, 81 districts are categorized as exposed to palm oil price shocks and 129 districts are exposed to rice price shocks.

1.5 Empirical results

I use the constructed exposure to price shocks to study how it affects districts on two fronts: a comparison between exposed districts and non-exposed districts and spillovers to non-exposed districts. I also show some mechanisms that can explain the results by analysing the responses in factors of production, especially labor and land.

1.5.1 Specification

I use the difference-in-difference method for econometrics specification to study the impact of palm oil price shocks and rice price shocks on districts' economies. Specifically, I perform an event study as in Equation 28 to show the average differences between exposed and non-exposed districts over time. Meanwhile, I use Equation 29 to show any heterogeneity in the impact of the shocks.

$$y_{dt} = \alpha + \sum_i \sum_{r \neq 2005} \beta_{ir} \left(I_{di} \cdot \mathbb{1} \left(year_r = t \right) \right) + \boldsymbol{X_d} \cdot t\gamma \cdot + \delta_d + \delta_t + \epsilon_{dt} \qquad (28)$$

$$y_{dt} = \alpha + \sum_{r \neq 2005} \beta_{i=palm,gr} \left(I_{i=palm,dg} \cdot \mathbb{1} \left(year_r = t \right) \right) + \lambda_t S_{i=rice,d} \cdot t + \boldsymbol{X_d} \cdot t\gamma + \delta_d + \delta_t + \epsilon_{dt} \quad (29)$$

The outcome variables, y_{dt}, are average real expenditure per capita and net-inward migration at the district level. Our coefficient of interest is β_{ir}s, i.e., the coefficient for the indicator variable for exposure status for crop $i \in \{palm, rice\}$ in year r, or coefficient β_{igr}s, i.e., the coefficient for tercile g in exposure to shocks of crop i in year r. These coefficients show the difference between districts exposed to price shocks in crop i and the non-exposed districts in year r relative to 2005 as the base year.

Furthermore, as Fact 3 in Section 2 reveals, districts with a high share of the agriculture sector in their economies can be structurally different because they tend to be poorer compared to those that rely less on the agriculture sector. Hence, I include a matrix of control variables to take this fact into account. These controls include the percentage of the rural population in 2000, the share of villages with asphalt roads in 2000 and the length of district roads in bad condition. These variables represent structural conditions that may matter in terms of supporting growth, such as inherent trade costs. I also include the size of a district's output in the mining sector in 2000 to control for the impact of the commodity boom on mining commodities. Meanwhile, I control for the district's output in the manufacturing sector in order to control for what could be a Dutch disease channel, in which a non-exposed sector may experience lower investment and growth or increasing costs from non-tradables. All of the control variables are interacted with year fixed effects. In addition, I include district fixed effects and year fixed effects. Thus the coefficients of interest capture the within-district changes in the outcome variables.

The difference-in-difference specification can establish the causal impact of exposure to the price shocks if it fulfills three assumptions. First, there is a parallel trend between the exposed districts and the non-exposed districts. Second, the price shocks are exogenous shocks to districts. In addition to the fact that exogenous components were used to construct the exposure to shocks, exogeneity is fulfilled because there is no uptick in the coefficients of interest during pre-treatment period. The plots of the coefficients of interest confirm that the first and second assumptions are fulfilled. Third, there is no change in crop productivity. If crop productivity increased due to the price shocks, then the coefficients are biased because they also capture the impact of the increase in productivity. Tables 8 and 9 confirm that there are no changes in actual yield for either palm oil or rice in the period of study. Hence, the third assumption is also fulfilled. Thus, the coefficients of interest reflect the impact of exposure to palm oil price shocks and exposure to rice price shocks.

1.5.2 Impact of the exposure to palm oil price shocks

Districts exposed to palm oil price shocks had higher (ln) real expenditure per capita during the peak of the boom in 2011 and 2012. Figure 13 plots the estimated β_{ir}s for palm oil price shocks and their respective 95% confidence obtained from running Equation 28. This result shows that income shocks from palm oil prices were translated as an increase in purchasing power.

Figure 13 also shows that the exposed and non-exposed districts were not significantly different in the pre-treatment period of 2000 to 2004 relative to the base year 2005. One exception is that districts exposed to palm oil price shocks had significantly lower (ln) real expenditure per capita in 2002. However, the difference is negligible in other years. Hence, the results shown by the coefficients of interest, β_{ir}s, establish the valid causal impact of the palm oil price shocks.

The palm oil price shocks increased the real expenditure per capita in the exposed districts by 6 log points or approximately 6% relative to the base year at its peak in 2011 and 2012. This effect corresponds to 37% of one standard deviation in the proportional change of real expenditure per capita in 2011 and 2012 relative to 2005. The impact of the commodity boom decays afterward, with coefficients not different from zero. The cycle seems to directly follow the global commodity prices, which started to decline in 2013 and 2014 as well. This result fills a gap in the literature by providing the first evidence that the commodity boom affected subnational regions differently and that these regions experienced a temporary windfall.

Among districts exposed to palm oil price shocks, I find heteregeneity in the impact of palm oil price shocks. Figure 14 plots the estimated coefficient for three terciles of palm oil price shocks over time. Districts in the bottom two terciles of palm oil price shocks had a significantly higher (ln) real expenditure per capita during the post-treatment period compared to the non-exposed districts. Following the trend in the overall impact of palm oil price shocks, the impact of the commodity boom dissipates as the boom ended in 2013.

Because districts exposed to palm oil price shocks had higher expenditure per capita, they might have attracted labor to move to them. To test whether districts exposed to the shocks received more migration, I run Equation 28 on net-inward migration and share of net-inward migration relative to district population. Figure 15 plots the estimated β_{ir}s for net-inward migration as the outcome variable, while Figure 16 plots the coefficients for share of net-inward migration as the outcome variable.

Before I continue with the analysis of the results, I would like to describe some of its limitations. Because recent migration data was not collected annually before 2011, I combine several datasets to construct recent migration flows data over time. For the years 2000 and 2010, I use the Census Population that is provided by IPUMS. For year 2005, I extract recent migration flows from the Inter-Census Population Survey provided by IPUMS. For the years 2011 to 2014, I use the Socio-Economic Household Survey(*Susenas*) datasets. Hence, there may exist some structural differences in the sampling of these datasets.[26] For this reason, in the analysis of migration as the outcome variable, I include the year 2010 as part of the post-treatment period.

Both Figures 15 and 16 show that districts exposed to palm oil price shocks receive more net-inward migration compared to the non-exposed ones in 2010 relative to the base year

[26]Table 2 tabulates the main statistics across sources of recent migration data.

2005, despite no significant difference in the years afterward. These results support the previous findings that districts exposed to palm oil price shocks become more attractive to labor to move to these regions. Because we find that labor responds to incentives to move to booming regions, the price shocks too are no longer fully localized.

Confirming the heterogeneous findings about the impact to real expenditure per capita, I also find that the districts exposed to palm oil price shocks in the bottom tercile are the ones that receive significantly more net-inward migration. Figures 17 and 18, respectively, show the impact of the commodity boom on net-inward migration and the share of net-inward migration across terciles.

The empirical results here show that once the positive windfall has a significant effect, we see that labor responds by moving as these booming districts became more attractive. This finding adds to the understanding of how trade shocks affect labor mobility. Many studies in this field find that trade shocks tend to be localized; see, for example, Autor et al. (2013) for the case of the US, Dix-Carneiro and Kovak (2017) for the case of Brazil, and Topalova (2010) for the case of India. However, most such studies explores trade shocks that are disadvantegous to local incomes. Hence, if there is a cash-in-advance constraint on migration costs, we may not see labor mobility responses to such trade shocks. The fact that I find a contrasting result does not necessarily mean that Indonesia is a special case. Instead, the result here provides some evidence that the labor mobility margin can be active when trade shocks are advantegous to local income. One possible explanation is that such trade shocks can help labor overcome the cash-in-advance constraint on migration costs.

1.5.3 Spillover to non-exposed districts

Booming districts may also demand more goods and services from nearby districts because it is cheaper to purchase from nearer districts than from more distant districts, due to lower transportation and transaction costs. To assess whether there is any spillover of impacts of exposure to palm oil price shocks to non-exposed districts, I run the following specification.

$$y_{dt} = \alpha + \sum_{g \in 1,2,3,4} \sum_{r \neq 2005} \beta_{gr} \left(I^g_{dt} \cdot \mathbb{1} \left(year_r = t \right) \right) + \psi_{palm,d} + \delta_{rice,d} + \boldsymbol{\gamma X_d} + \delta_d + \delta_t + \nu_{dt} \quad (30)$$

In Equation 30, the outcome variables are real expenditures per capita and migration flows. As in the previous specifications, I include a set of control variables, district fixed effects and year fixed effects. First, I control for the potential yield in growing palm oil, $\psi_{palm,d}$, to purge the effect from the impact of the districts changing status from palm-oil non-grower to grower. I also add the status of exposure to rice price shocks, $\delta_{rice,d}$. I run the specification on a panel of districts that are not exposed to the palm oil price shocks. To capture heterogeneity due to proximity to exposed districts, I create four dummy variables. Each dummy variable indicates four of the lowest centiles of minimum distance to exposed districts.[27] Hence, the coefficients of interest are β_{gr}s. These coefficients capture the difference of district of centile g in year r compared to districts in the 5th to 10th centiles (the control group) relative to the base year 2005.

First, I find that the nearest non-exposed districts to districts exposed to palm oil price shocks also had higher real expenditure per capita. Figure 19 plots the coefficients of interest with (ln) real expenditure per capita as the outcome variable for the distriicts in the two lowest centiles in distance. These coefficients are positive and statistically significant from zero for the nearest non-exposed districts. Following the trend in the impact to the exposed districts, these coefficients also shrink over the outcome period.

In response to the spillover indicated by higher expenditure per capita in the neighboring districts of booming regions, I find also that the same non-exposed districts that are close to districts exposed to palm oil price shocks also receive more net-inward migration. Figure 20 plots the estimated β_{gr}s for net-inward migration as the outcome variable. Supporting the result above, labor seems to respond to the higher purchasing power provided by these

[27]The distance between two districts is computed as the distance between their centroids.

nearest districts. These districts receive more net-inward migration compared to the control group, which is further away from the districts exposed to palm oil price shocks.[28]

1.5.4 Mechanisms

I provide several mechanisms, focusing on the response of factors of production. The idea is that the shocks may have lasted long enough and were big enough that the factors of production also responded to the shocks. First, I provide justification that labor responds through internal migration by analyzing the impact of the price shocks on district premia. Second, because I focus on agricultural commodities, I analyze two possible methods through which the agriculture sector expands: extensification by land expansion and intensification by increasing yield.

1.5.4.1 District premia: the role of internal migration

One may argue that, structurally, districts exposed to palm oil price shocks have a different labor and sectoral composition that may drive their higher expenditure per capita at the peak of the boom. Another argument is that there exist frictions in labor mobility that prevent welfare from equalizing across districts. I follow the two-step method used by Dix-Carneiro and Kovak (2017) to analyse the evolution of district premia over the period of study. First, to control for labor and sectoral characteristics, I run a Mincerian-type regression on household-level expenditure per capita by controlling household heads' economic and demographic variables. To avoid selection bias due to labor market biases, I follow Bryan and Morten (2019) in imposing some selection criteria. That is, I include households with male heads of households between the ages of 15 and 61. I also take only those who report having had an income in the three months prior to the survey. Equation 31 below shows the Mincerian equation.

[28]Due to the combination of various sources of data for migration, I also loosely take 2010 as part of the outcome period here.

$$y_{\omega dt} = \alpha + \boldsymbol{\beta X_{\omega dt}} + \delta_{dt} + \delta_{it} + \delta_{st} + \epsilon_{\omega dt} \tag{31}$$

The outcome variable is individual ω's real expenditure per capita in year t, living in district d. I include the vector of the household heads' controls, such as years of education, years of experience and years of experience squared. I run this regression separately for each year $t \in [2002, 2005, 2011, 2012, 2013, 2014]$[29] and take the estimated district fixed effects, δ_d, as the district premia. Note that I also add fixed effects for sector of employment, δ_i, and status of employment (self-employed, employee, etc.), δ_s. The fixed-effects on sector of employment are particularly important to purge any premium from working in a particular sector, including the agriculture sector that faced the price shocks. Thus, the district premia explain the premium on real expenditure per capita by simply living in a particular district.

Second, I run Equation 28 with the estimated district premia as the outcome variable. Figure 21 shows the estimated coefficients of interest that show the difference in district premia between exposed and nonexposed districts. Neither set of coefficents on exposure to palm oil and rice price shocks is statistically different from zero. This result implies that after controlling for labor composition and sectoral premium, there is no significant difference between the exposed and non-exposed districts. It also implies that the positive impact of palm oil price shocks on exposed districts is not driven by labor market friction.

This result stands in contrast to what Dix-Carneiro and Kovak (2017) find in the case of the impact of trade liberalization in Brazil, where frictions to labor mobility amplified the impact of trade shocks locally. In the Brazilian case, the district premia grew more negative over time, because affected labor could move out of the regions where trade liberalization hit industries worse. Meanwhile, in this study, the fact there is no significant impact on district premia due to exposure to palm oil price shocks also implies that there are no frictions that are significant enough to prevent people from moving in order for the district premia to

[29] Due to insufficient representativeness of the selected sample in *Susenas* 2008, I exclude 2008 from the estimation of district premia. Appendix **??** provides more details on the data and estimation construction.

equalize across districts. In regard to the positive impact of the palm oil price shocks to real expenditure in palm oil districts, the finding on district premia shows that labor is mobile enough to diffuse the income-enhancing shocks from the exposure to palm oil price shocks.

1.5.4.2 Extensification versus intensification

To find the drivers of the growth of crops, I use changes in harvested area as the outcome variable for crop extensification and changes in actual yield for crop intensification. Using difference-in-difference specification, I use a two-period panel of districts to see the difference before and after the price shocks. In particular, I use the year 2001 as the pre-treatment period and 2011 as the post-treatment period.

The palm oil crop expanded through extensification. Table 10 shows that especially for the bottom tercile of exposed districts, the coefficients for the post-treatment period on the harvested area are positive and significant. Given that there was more land to work on, demand for labor may have increased. This increase in demand is consistent with the increase in real expenditure per capita and net-inward migration in exposed districts, as discussed above.

Meanwhile, there is no indication that the palm oil crop expanded through intensification. Table 8 shows that the coefficients for the post-treatment period on actual yield are not significantly different from zero. Furthermore, it is worth noting that because the commodity boom did not last forever, the impact of the price shocks due to the boom also lowered as commodity prices started to decline. This finding may provide a warning to policy-makers that the palm oil sector may not provide a sustainable source of growth if the sector continues to rely on growth from land expansion.

1.5.4.3 Discussion of deforestation

Globally, commodity-driven deforestation is rampant.[30] In a meta-analysis of drivers of deforestation, Busch and Ferretti-Gallon (2017) mention that agricultural price as one of the drivers associated with higher deforestation. Indonesia also is also special in this regard because it experienced the largest increase in forest loss.[31] In the case of Indonesia, various studies show that palm oil expansion was the main driver of deforestation, at least until 2014. Figure 22 shows the trend of annual forest loss driven by palm oil plantation in Indonesia and real palm oil prices. We can see that there is still a fairly strong positive correlation.

The main finding on the impact of palm oil price shocks is that palm oil-producing districts benefited for several years. In line with what Edwards (2018) find, palm oil-producing districts experienced faster poverty reduction. He also shows that this gain comes with some costs, these districts also experienced more deforestation. The finding in this paper emphasizes that the gain did not last permanently. As world prices started to decline in 2013-2014 without an increase in actual productivity, the return to palm oil for these districts dissipated. This evidence can help policy-makers and the public to understand the impact of the commodity boom in palm oil while taking into account the potential social cost that deforestation imposes over a long period. In this regard, I echo the concern emphasized by Wheeler et al. (2013) that the success of forest conservation efforts need to acknowlege the fluctuations in world markets and decisions made by financial authorities on the exchange rate and the interest rate. Monetary authorities should be cautious when relying on the primary commodity as the backbone of exports and hence the source of foreign reserves. As shown in Section 1.2, Indonesia's export profile has become more commodity-intensive since the commodity boom in the mid-2000s. Meanwhile, because local leaders have the power in land concession as shown by Burgess et al. (2012), this evidence offers a realistic assessment of the opportunity cost of forests. A recent study on the spillover impact of cash transfers on

[30]See Curtis et al. (2018) and Seymour and Harris (2019)

[31]See Hansen et al. (2013) and Seymour and Harris (2019).

deforestation by Ferraro and Simorangkir (2020) sheds lights on the importance of creating an outside option as a source of income in regions that are prone to deforestation. Lastly, the fact that there is no lingering benefit enjoyed by palm oil-producing districts highlights the possibility that new palm oil concessions may not provide more benefit than costs to the people there.

1.6 Quantitative estimation

Lastly, I quantify the welfare changes in Indonesia that occurred in the period between 2005 and 2010. I use the decomposition of welfare changes that I derived in the section on the theoretical framework. Specifically, I decompose the source of the welfare changes into gains from trade and gains from migration. To quantify both gains, I use internal migration flows data and the Inter-Provincial Input Output Table. I estimate that there was a 0.39% increase in welfare between 2005 and 2010. Gains from migrations account for one-third of these gains. This result indicates the importance of taking into account internal migration in welfare analysis.

1.6.1 Data and parameters

I present below the equation for welfare changes, as stated in Proposition 2. In estimating the gains from migration and terms-of-trade gains, I use several dataset sources. First, I compute the regional expenditure shares, φ_n , as total households expenditures by district by multiplying the average expenditure per capita by the population of each district. I use data from *Susenas* 2011. I also obtain the net-inward migration rate from the same dataset. Extracting from its recent migration questions, I obtain data on changes in districts' labor, $\hat{L}_n$, as well as the population shares, λ_n.

$$\hat{U} = \underbrace{\left(\frac{1}{\epsilon} + (1-\alpha)\right) \sum_n \hat{L}_n \left(\varphi_n - \lambda_n\right)}_{\text{gains from migration}} - \underbrace{\frac{\alpha}{\theta} \sum_n \hat{\pi}_{nn} \varphi_n}_{\text{gains from trade}} \tag{32}$$

Meanwhile, to estimate the gains from trade, I need to have data on domestic (regional) trade shares, π_{nn}. Since there is no data on inter-district trade, I use a more aggregate version of inter-regional trade measures extracted from the Inter-Provincial Input-Output Table 2005 constructed by Resosudarmo and Nurdianto (2008) and the Inter-Provincial Input-Output Table 2010 by Resosudarmo and Hartono (2020).

Next, I assume the value of parameters as shown in Table 11. I use conservative values as assumptions for parameters, as in Redding (2016) and Bryan and Morten (2017). Armed with data on expenditure shares, population shares, domestic trade shares and the parameters, I compute the gains from migration for each district and gains from trade for each province.

1.6.2 Results

The total welfare gain over the period from 2005 to 2010 is a welfare increase of 0.39% (proportional change to the initial state in 2005) welfare increase. When I decompose the welfare gains, gains from migrations account for one-third of the gains, while gains from trade account for two-thirds of the gains. The overall size of the welfare gains is in line with the welfare estimation in the literature. For example, Broda and Weinstein (2006) estimate that US consumers experienced 2.6% of GDP welfare gains from expanded import varieties between 1972 and 2001.

Gains from migration Gains from migration in this paper are quantified from two variables: districts' population shares and the difference between districts' expenditure shares and population shares. Figure 23 compares these two variables according to exposure to palm oil price shocks. The color of each hexagon on the graphs represents the share of exposed districts in that particular bin of population shares and the difference between expenditure shares and population shares.

We can see that many districts exposed to palm oil price shocks gain through migration, because they have a positive value for the difference in expenditure shares and population shares, i.e., the districts are richer. These districts received positive net-inward migration. Some portion of the districts have around zero or negative net-inward migration, but their values for the difference of expenditure shares and population shares are also negative. Such districts gain by experiencing outmigration.

Gains from trade Meanwhile, given that there are no data for district-level domestic trade shares, I use provincial-level (a more aggregated level than the district level) domestic trade shares to compute gains from trade. The result for each province is presented in Table 12. Several palm oil producers are the main contributors to the gains, such as Kalimantan Selatan, Kalimantan Timur, Kalimantan Barat and Sumatera Utara. Others, however, experienced losses, such as Jambi and Riau. These results are driven by changes in (provincial) domestic trade shares. Palm oil-producing provinces tend to have lower domestic trade shares in 2010 compared to 2005 as their export shares in their economy roared due to the commodity boom.

1.7 Conclusion

Developing economies are vulnerable to changes in the world commodity markets. This paper studies the impact of price shocks on Indonesia in the mid-2000s. Given the magnitude and the length of the commodity boom that exposed Indonesia as one of the main palm oil producers, factors of production, including labor, may have responded to these shocks by moving to districts directly exposed to the shocks. In particular, I study the impact of price shocks on different districts in the presence of internal migration.

I present three main findings. First, palm oil price shocks benefitted producing districts with higher real expenditure per capita. However, the impact of the palm oil price shocks was temporary. I find that the palm oil sector grew through land expansion without any significant growth in actual yield. The increase in land that needed to be cultivated was met by more inward migration and higher real expenditure per capita.

The second main result is that there is evidence of spillover of the shocks to non-exposed districts. In particular, the non-exposed districts nearest to districts exposed to palm oil price shocks also experienced higher real expenditure per capita and net-inward migration. The intuition behind this result is straightforward. Booming districts may demand more goods and services due to the income shocks they enjoy. Hence, they demand more from their surrounding districts, because trade and migration costs are lower if they buy from nearby sources.

Third, I estimate that there was a 0.39% welfare increase between 2005 and 2010 in the economy. One-third of the welfare gains during the period of interest is associated with gains from migration. Meanwhile, gains from trade account for the remaining two-thirds of the welfare increase. These results shed light on the importance of taking into account labor mobility as represented by internal migration in welfare analysis.

These results provide policy-relevant lessons. First, I provide evidence of the impact of global prices' cyclicality at the sub-national level. The result then questions the sustainability of relying on cash crops through land expansion. The concern about sustainability is even more critical if we take into account the social costs of land expansion that causes deforestation. This evidence can inform not only local governments who hold the authority to make land concessions and who may have an interest in creating local development strategy, but also national-level fiscal and monetary authorities who are interested in sustaining sources of foreign reserves and growth in general. In addition, the concern about commodity-driven deforestation is not exclusive to Indonesia; we can see the same pattern in other crop-exporting regions.

Appendix 1

Tables

Table 1: Summary Statistics

Indicator	**2000-2005**	**2005-2010**	**2010-2015**
GDP growth	4.7	5.7	5.5
Export growth	4.5	12.9	-0.1
Growth of expenditure per capita	13.0	15.8	11.1
Growth of real expenditure per capita	3.3	7.4	5.0
	2000	**2010**	**2011-2014**
National recent migration rate	5.2	4.0	3.2
Net-migration rate of the top 10% district	7.4	4.5	
Net-migration rate of the bottom 10% district	-6.6	-3.1	
	Jan 2001 to Dec 2005	**Jan 2006 to Dec 2010**	**Jan 2011 to Dec 2015**
Price of palm oil, world market (USD/ton)	362	701	817
Price of rice, domestic market (IDR/kg)	3,117	5,887	9,292

Sources:World Development Indicator for GDP and exports. Population Census for migration rate in 2000 and 2010, Social-Economic Household Survey (*Susenas*) for the average of recent migration rate in 2011-2014. INDO DAPOER dataset by the World Bank for expenditure per capita. IMF Commodity Price Series for price of palm oil. BPS for price of rice. All growth figures and averages are the author's calculations.
Notes: All growth figures are annualized growth rates. Nominal and real expenditure per capita are the median of district-average nominal and real expenditure per capita. Migration is recent migration, i.e., change of residence within five years prior to the survey or census year. Price of palm oil is the simple average of the nominal price in the world market in each period. Price of rice is the average of the nominal domestic price of rice in each period. Domestic price of rice is the average of provincial prices.

Table 2: Summary statistics of net-inward migration rate by year (in percent)

Year	N	mean	p50	p10	p90	sd
2000	339	-0.29	-0.94	-6.6	7.44	7.73
2005	317	-0.14	-0.38	-2.8	3.26	2.89
2010	342	0.26	-0.30	-3.09	4.50	3.57
2011	342	0.10	-0.25	-2.37	3.46	2.82
2012	342	-0.06	-0.14	-2.4	2.99	3.2
2013	342	-0.16	-0.27	-2.18	2.51	2.97
2014	342	0.37	-0.3	-2.32	2.73	8.4

Sources: Population Census 2000 and 2010 from IPUMS for year 2000 and 2010, Inter-Census Population Survey 2005 for 2005 from IPUMS, *Susenas* for 2011-2014. Author's calculation.

Notes: Net-inward migration rates are calculated at the district level as as defined in 2000. Inter-Census Population Survey 2005 does not include districts in the Nanggroe Aceh Darussalam Province.

Table 3: Land shares of main crops

Crops	Area (million ha.)		Share (%)	
	2000	2010	2000	2010
Rice	12	13	37	33
Palm oil	2	6	6	14
Maize	4	4	11	10
Rubber	2	3	8	9
Coconut	3	3	8	7

Sources: FAO, author's calculation.

Notes: Shares of each crop refers to their shares relative to total land for crops.

Table 4: Gravity of migration flows

	Dependent var.: number of migration from origin to destination (1)	(2)
exp/cap: origin	-0.00302	0.0236
	(0.132)	(0.139)
exp/cap: destination	0.641***	0.564***
	(0.126)	(0.132)
distance	-1.304***	-1.288***
	(0.007)	(0.008)
Control: est. amenities	no	yes
Origin FE	yes	yes
Destination FE	yes	yes
Year FE	yes	yes
N	973210	803736
R2	0.427	0.428

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Gravity equation is estimated using Poisson pseudo-maximum likelihood estimation (PPML) on a panel of origin-destination district pairs from 2011 to 2014. Estimated amenities are predicted first components from running principle component analysis (PCA) on selected variables from the Village Census (PODES) 2005 and 2008.

Table 5: Net-inward migration rates by crop suitability

Year	**palm oil**			**rice**		
	bottom 20%	**median**	**top 20%**	**bottom 20%**	**median**	**top 20%**
2000	-2.1	-0.87	1.2	-1.6	0.0	0.5
2010	-0.05	-0.42	1.3	0.4	0.34	-0.15

Source: Population Census 2000 and 2010 for netmigration rates. FAO GAEZ dataset for potential yield. Author's calculation.
Notes: Migration refers to recent migration, i.e., changes of residence between five years prior to the census year and the census year. Potential yield is district averages potential yield.

Table 6: Summary statistic of exposure to price shocks

Statistic	rice	palm oil
p10	0	0
p20	0.0001	0
p30	0.002	0
p40	0.016	0
p50	0.044	0
p60	0.068	0
p70	0.089	0
p80	0.117	0.0005
p90	0.170	0.015
p100	0.431	0.143
mean	0.094	0.016

Table 7: Number of exposed and non-exposed districts

Group	**palm oil**	**rice**
exposed districts	81	129
non-exposed districts	240	192

Table 8: Crop intensification: Actual yield for palm oil

	Dep. var: actual yield		
	(1)	(2)	(3)
Bottom tercile, 2011	0.513	0.512	0.556
	(0.546)	(0.561)	(0.562)
Second tercile, 2011	0.316	0.317	0.317
	(0.410)	(0.411)	(0.413)
(ln) Potential yield: palm-oil		0.00332	-0.00512
		(0.493)	(0.467)
Price shocks: rice			-1.755***
			(0.605)
N	180	180	180
R2	0.100	0.100	0.133

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable is (ln) actual yield for palm oil. The regressions are run on a panel of districts with two periods. The two periods are the years 2001 and 2011. The coefficients for each tercile are relative to the top tercile in exposure to palm oil price shocks. Year FEs are included in all specifications. I use robust standard errors.

Table 9: Crop intensification: Actual yield for rice

	Dep. var: actual yield		
	(1)	(2)	(3)
Bottom tercile, 2011	0.100	0.101	0.101
	(0.083)	(0.083)	(0.083)
Second tercile, 2011	0.226	0.226	0.226
	(0.180)	(0.180)	(0.180)
(ln) Potential yield: rice		0.0574	0.0250
		(0.104)	(0.098)
Price shocks: palm			-0.921**
			(0.455)
N	557	557	557
R2	0.0159	0.0161	0.0216

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable is (ln) actual yield for rice. The regressions are run on a panel of districts with two periods. The two periods are the years 2001 and 2011. The coefficients for each tercile are relative to the top tercile in exposure to rice price shocks. Year FEs are included in all specifications. I use robust standard errors.

Table 10: Crop extensification: Palm oil

	Dep. var: harvested area		
	(1)	(2)	(3)
Bottom tercile, 2011	2.195***	2.195***	2.195***
	(0.546)	(0.547)	(0.549)
Second tercile, 2011	0.248	0.251	0.251
	(0.273)	(0.274)	(0.275)
(ln) Potential yield: palm-oil		1.310**	1.310**
		(0.543)	(0.545)
Price shocks: rice			-0.0729
			(0.523)
N	197	197	197
R2	0.507	0.526	0.527

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable is (ln) harvested area for palm oil. The regressions are run on a panel of districts with two periods. The two periods are the years 2001 and 2011. The coefficients for each tercile are relative to the top tercile in exposure to palm oil price shocks. Year FEs are included in all specifications. I use robust standard errors.

Table 11: Assumption for parameters

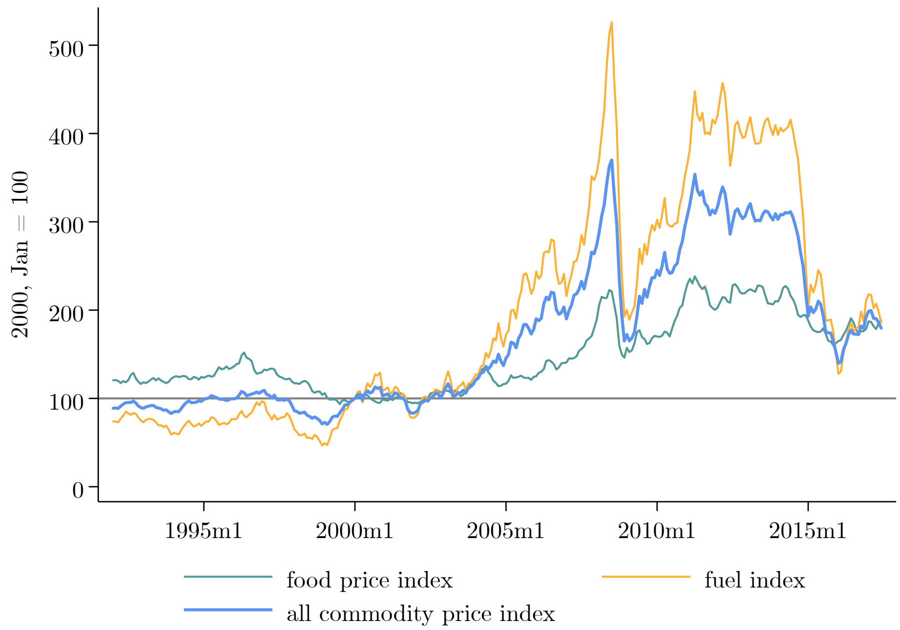
parameter	description	value
α	share of tradable goods in consumption basket	0.75
θ	Fréchet parameter for productivity	4
ϵ	Fréchet parameter for amenity	3

Table 12: Gains from trade

Province	gains from trade gains (% from initial welfare)	output share, φ_n (% of national)
NAD	-2.66	1
Sumatera Utara	0.98	5
Sumatera Barat	1.32	1
Riau	-0.43	7
Jambi	-0.42	1
Sumatera Selatan	0.41	3
Bangka Belitung	0.78	1
Bengkulu	-0.15	0.3
Lampung	-0.10	2
DKI Jakarta	2.45	16
Jawa Barat	-0.07	16
Banten	-2.16	4
Jawa Tengah	-3.39	9
DI Yogyakarta	1.10	1
Jawa Timur	-0.27	14
Kalimantan Barat	1.28	1
Kalimantan Tengah	-0.24	1
Kalimantan Selatan	16.71	1
Kalimantan Timur	0.79	6
Sulawesi Utara	0.43	1
Gorontalo	-0.04	0.1
Sulawesi Tengah	0.48	1
Sulawesi Selatan	-1.38	2
Sulawesi Tenggara	0.91	0.5
Bali	1.02	2
Nusa Tenggara Barat	2.81	1
Nusa Tenggara Timur	1.18	0.4
Maluku	7.49	0.1
Maluku Utara	11.73	0.1
Papua	-1.71	2

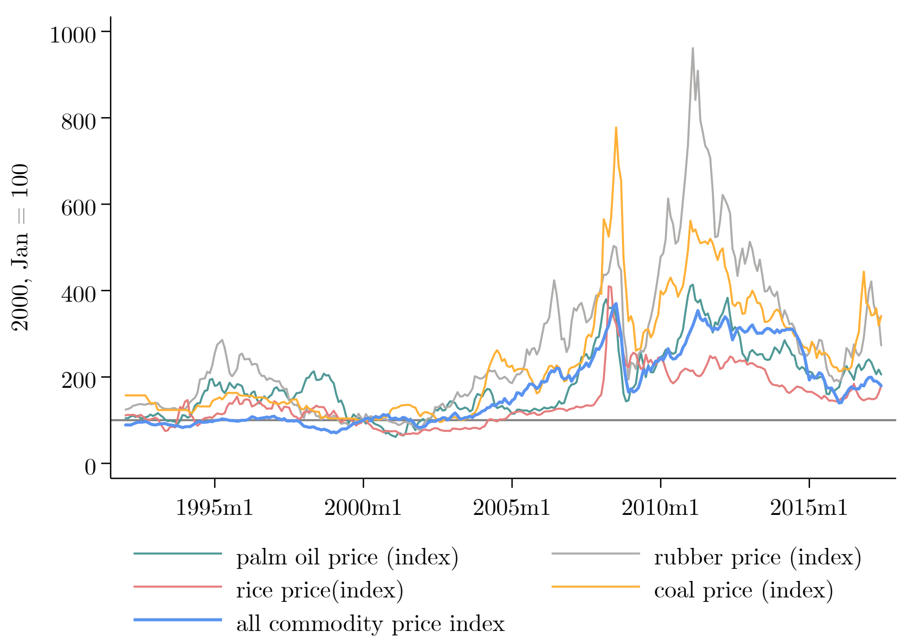
Figures

Figure 1: Trends in main world price indices



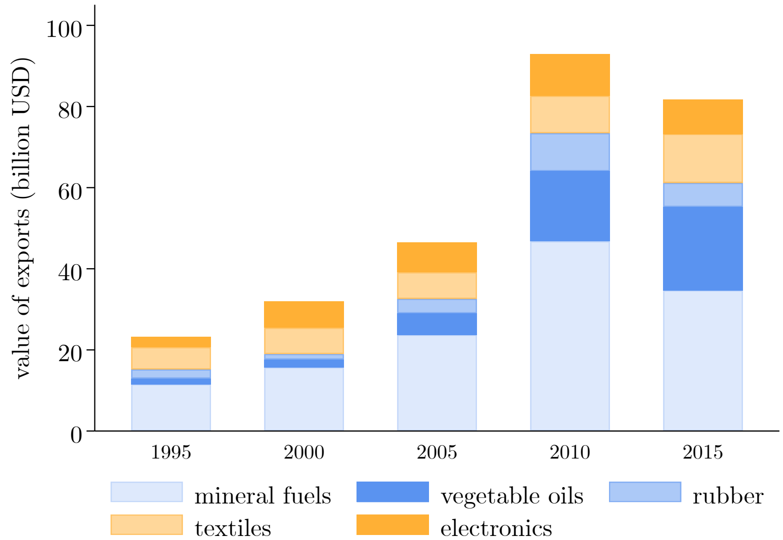
Source: IMF Commodity Price Series.

Figure 2: Trends in world price indices of Indonesia's main commodities



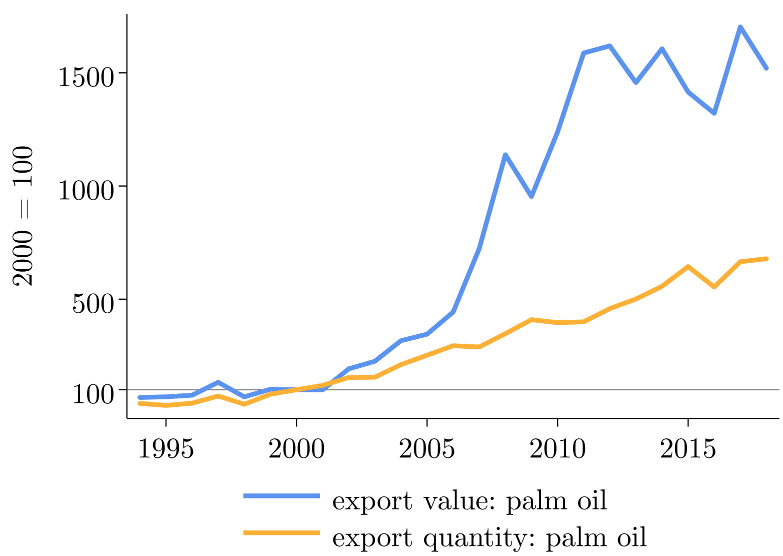
Source: IMF Commodity Price Series, author's calculation.

Figure 3: Indonesia's exports transformation



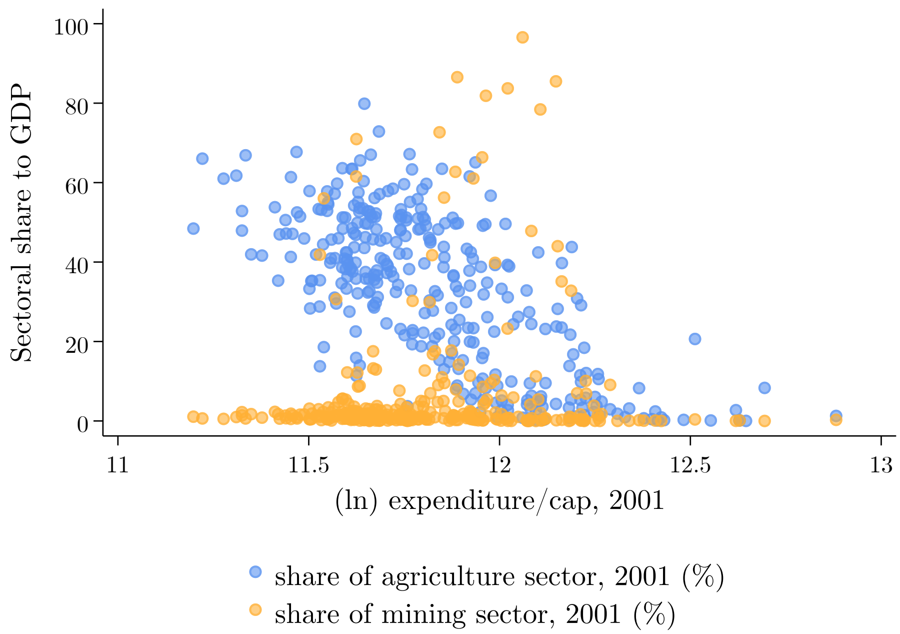
Source: UNCOMTRADE, author's calculation.
Notes: Mineral fuels refer to HS 27. Vegetable oils refer to HS 15, rubber refers to HS 40, textiles refers to HS 61 to HS 64. Electronics refers to HS 85. This figure shows selected export goods. Bars in blue represent primary-commodity exports, while bars in yellow represent manufacture exports.

Figure 4: Indonesia's palm oil exports



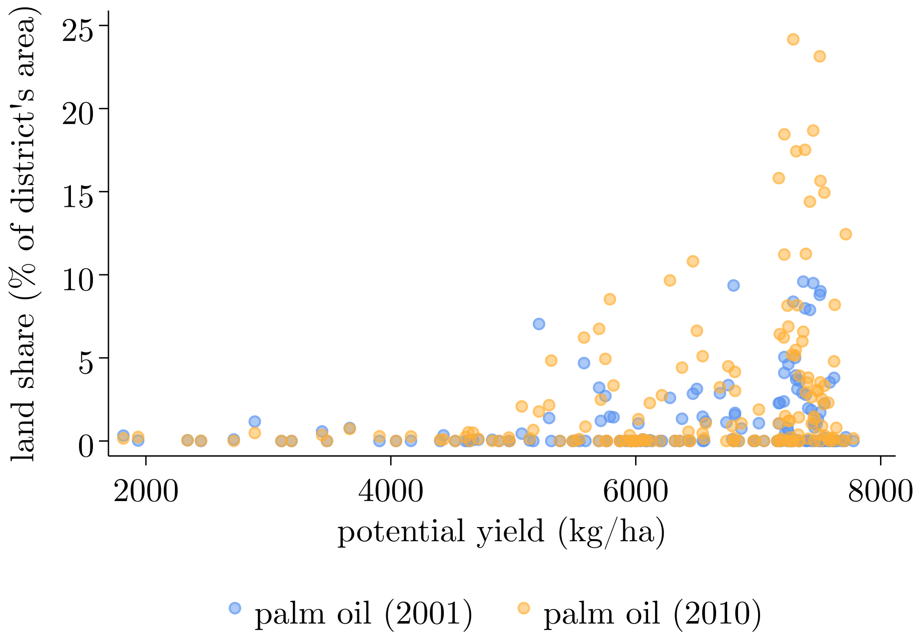
Source: UNCOMTRADE, author's calculation.
Notes: This figure compares the value and volume of exports of palm oil, defined as HS 1511.

Figure 5: Importance of the agriculture sector and mining sector across districts

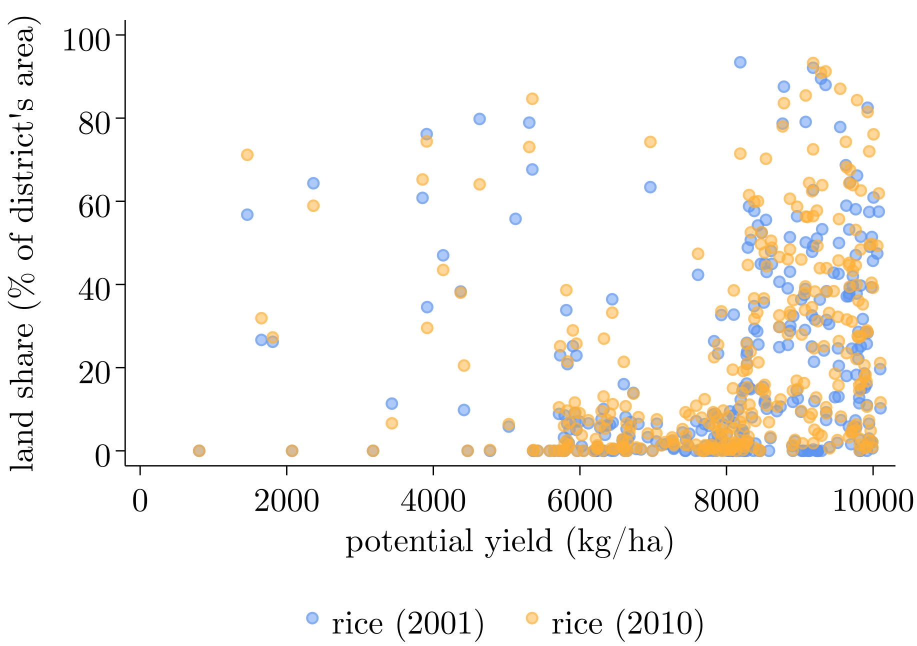


Source: INDO DAPOER, author's calculation.
Notes: Each unit in the scatter plots represents a district. Shares of each sector refers to share in district GDP.

Figure 6: Land shares of palm oil and rice by potential yield.



(a) palm oil

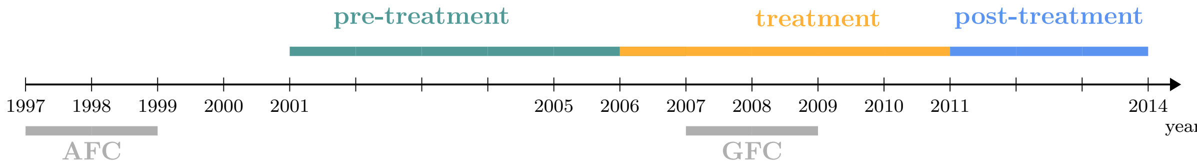


(b) rice

Source: Area for each crop is from Tree-Crops Statistics, Ministry of Agriculture. District total area is from World Bank's INDO DAPOER. Potential yield data is from FAO GAEZ dataset. Land shares are the author's calculation. District's potential yield is the average of potential yield in the district.

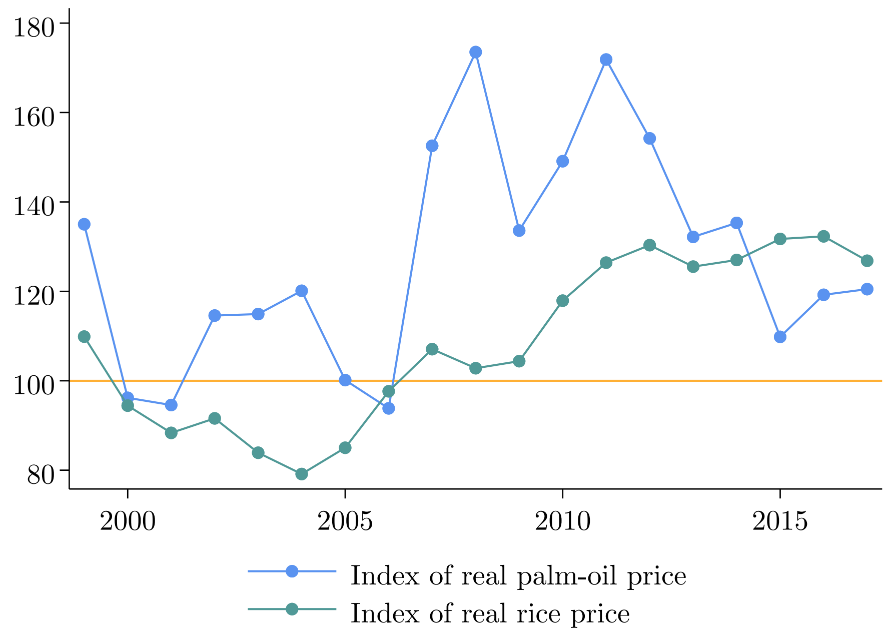
Notes: Each unit represents a district. I exclude districts with land share for each crop of more than 95% of the district's area.

Figure 7: Timeline



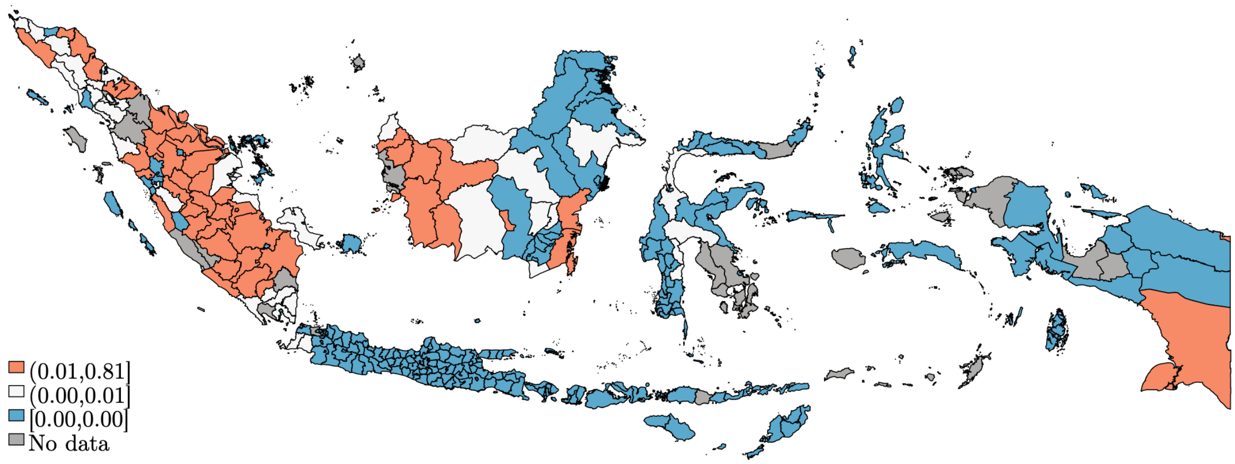
Notes: AFC stands for Asian Financial Crisis. GFC stands for Global Financial Crisis.

Figure 8: Real palm oil price and real rice price (Jan 2000 = 100)



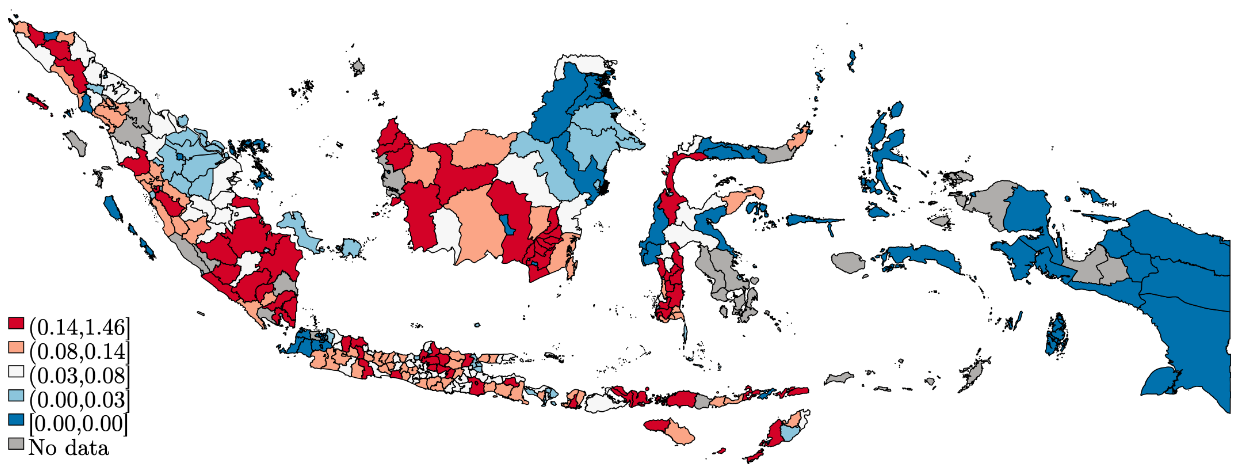
Source: IMF Commodity price series for world palm oil prices, FRED Database for exchange rates, BPS for provincial rice prices and Indonesian CPI. Author's calculation.
Notes: National rice prices are the simple average of provincial rice prices.

Figure 9: Exposure to palm oil price shocks



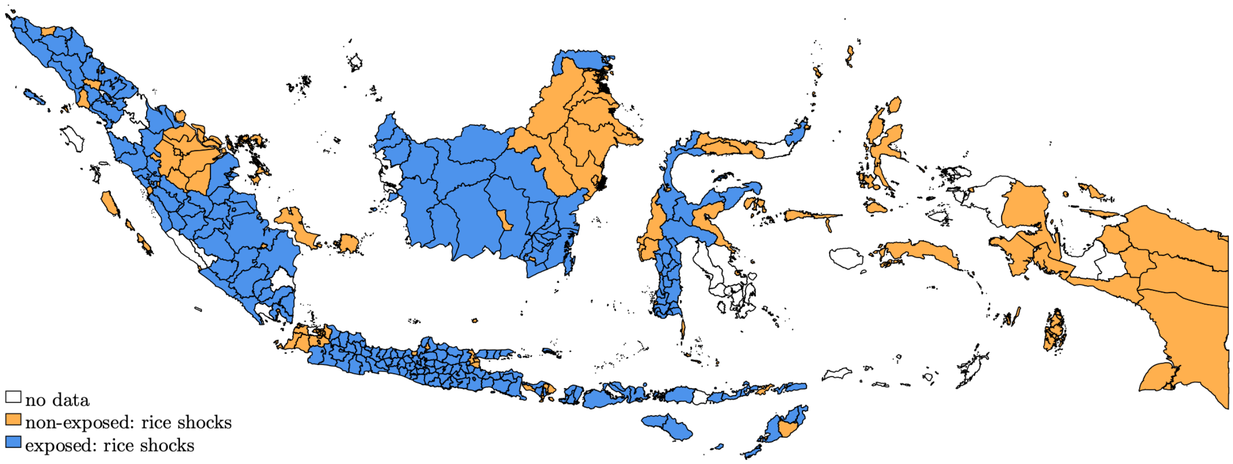
Notes: The definition of districts uses district boundaries in 2000. Exposure to price shocks is calculated using Equation (27).

Figure 10: Exposure to rice price shocks



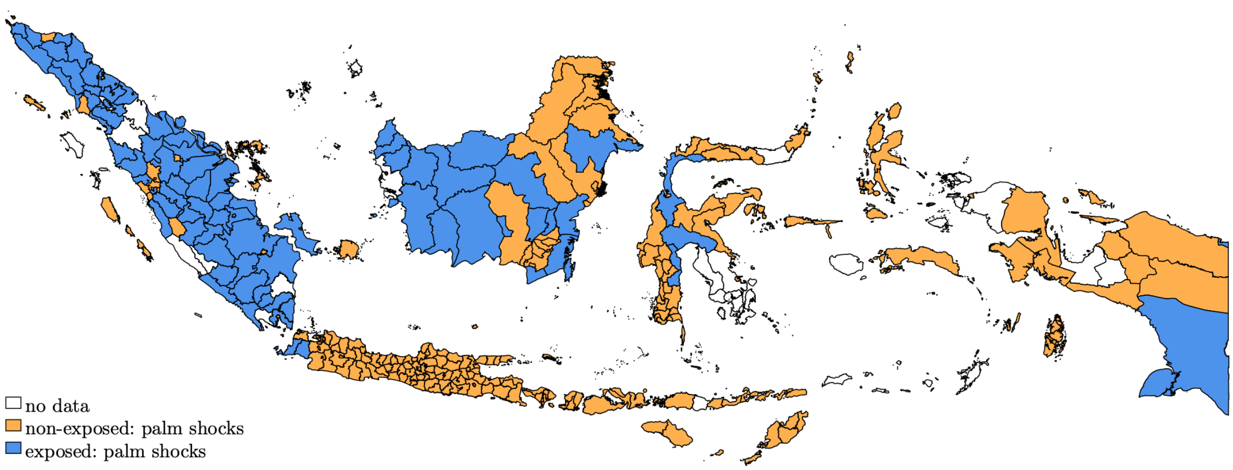
Notes: The definition of districts uses district boundaries in 2000. Exposure to price shocks is calculated using Equation (27).

Figure 11: Exposed and non-exposed districts: Rice price shocks



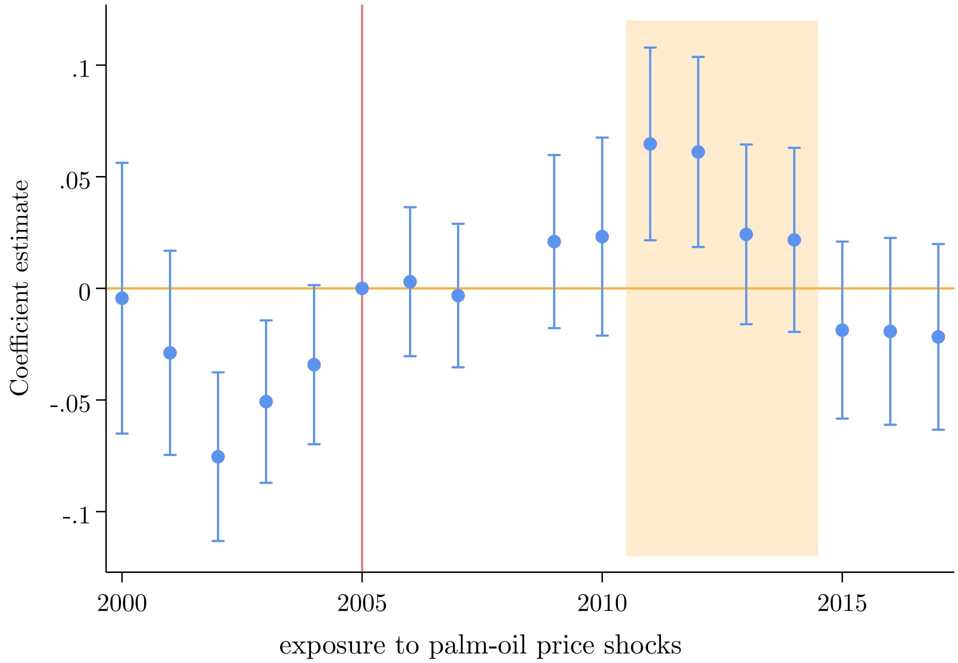
Notes: District definitions and borders use the district definitions in 2000. Exposed districts are defined as districts with exposure to rice price shocks of above 40 percentile.

Figure 12: Exposed and non-exposed districts: Palm oil price shocks



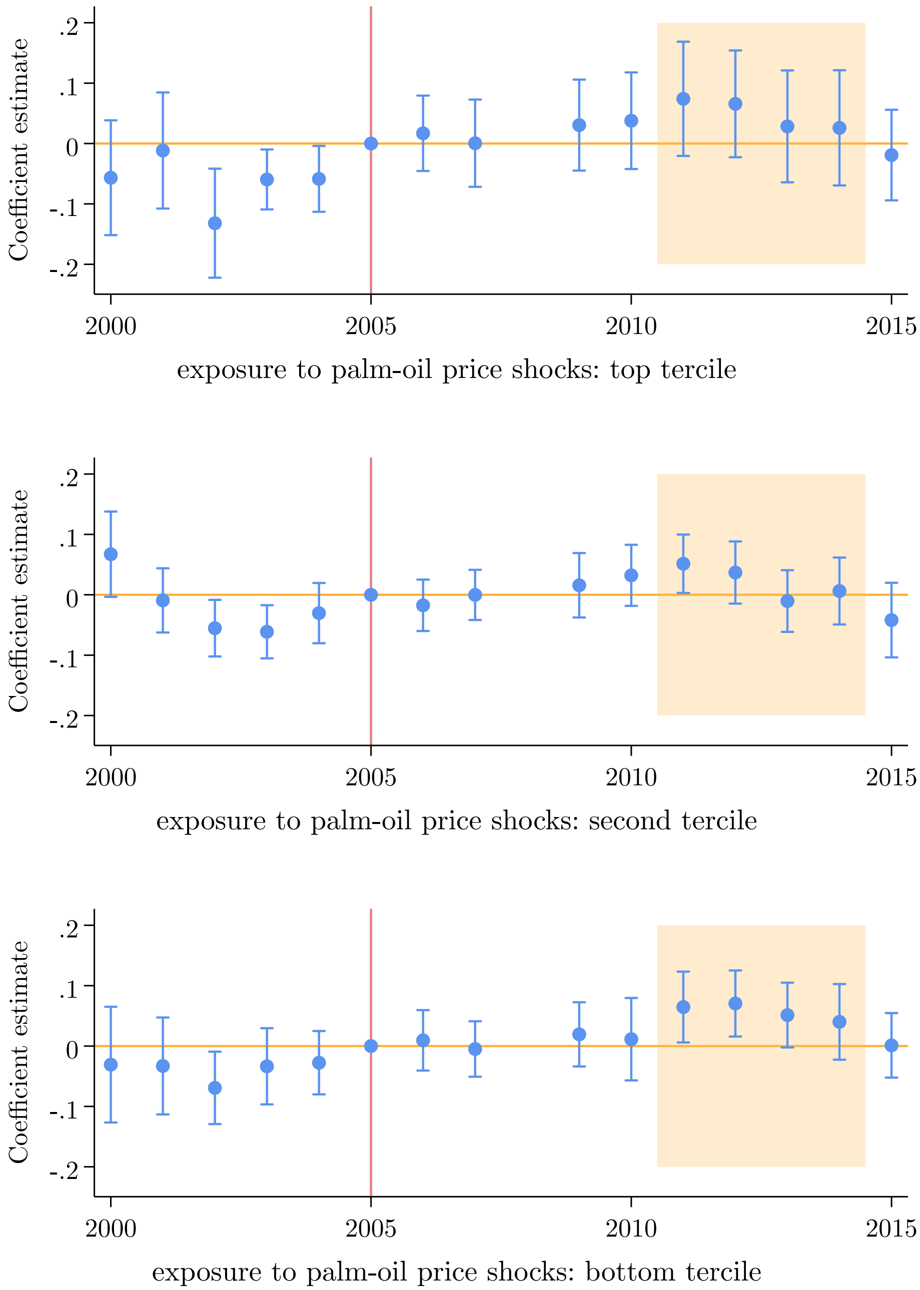
Notes: District definitions and borders use the district definitions in 2000. Exposed districts are defined as districts with a positive value of exposure to palm oil price shocks.

Figure 13: Impact of exposure to palm oil price shocks on real expenditure per capita



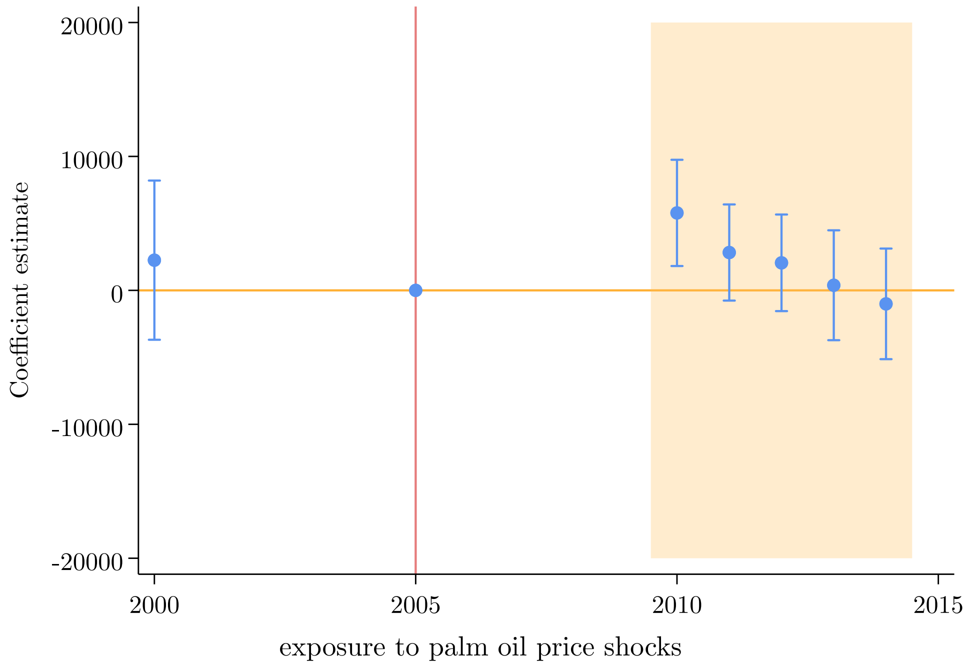
Notes: The dependent variable is the log of (district average) real expenditure per capita. The model includes control variables interacted with year, district fixed effects and year fixed effects. Regression is run on a panel of districts over year. Standard errors are clustered at the district level. Point estimates are relative to the year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

Figure 14: Impact of palm oil price shocks on real expenditure per capita across terciles



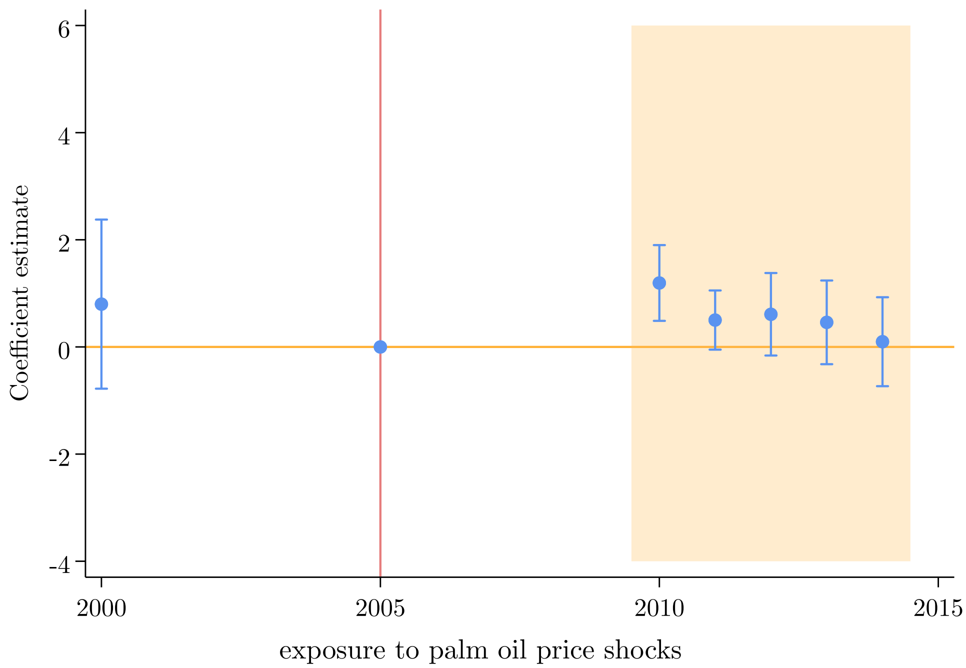
Notes: The dependent variable is (ln) real expenditure per capita. The model includes control variables interacted with year, district fixed effects and year fixed effects. Regression is run on a panel of districts over year. Standard errors are clustered at the district level. Point estimates are relative to the year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

Figure 15: Impact of palm oil price shocks on net-inward migration



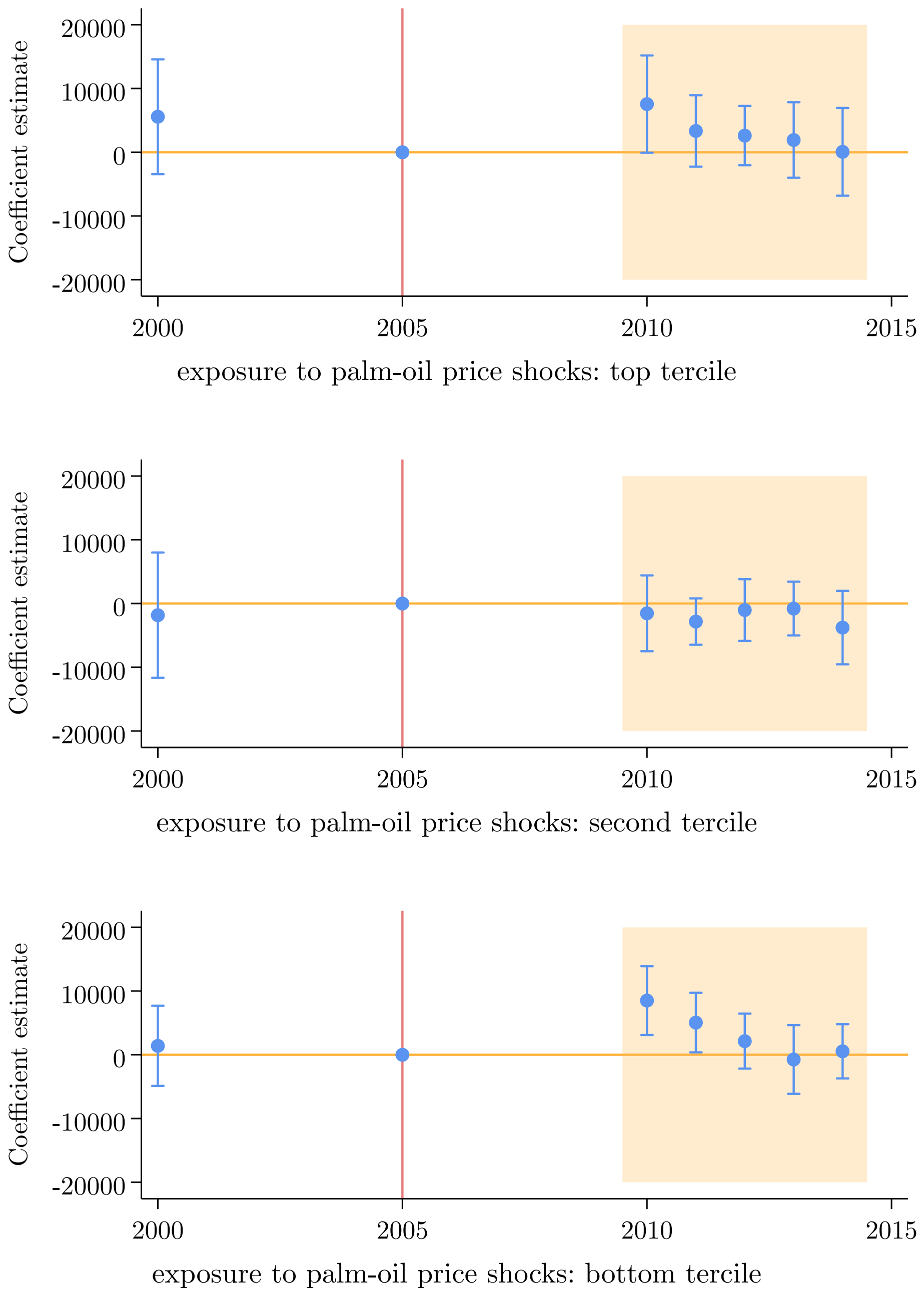
Notes: The dependent variable is the net-inward migration. The model includes control variables interacted with year, district fixed effects and year fixed effects. Regression is run on a panel of districts over year. Standard errors are clustered at the district level. Point estimates are relative to the year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

Figure 16: Impact of palm oil price shocks on share of net-inward migration



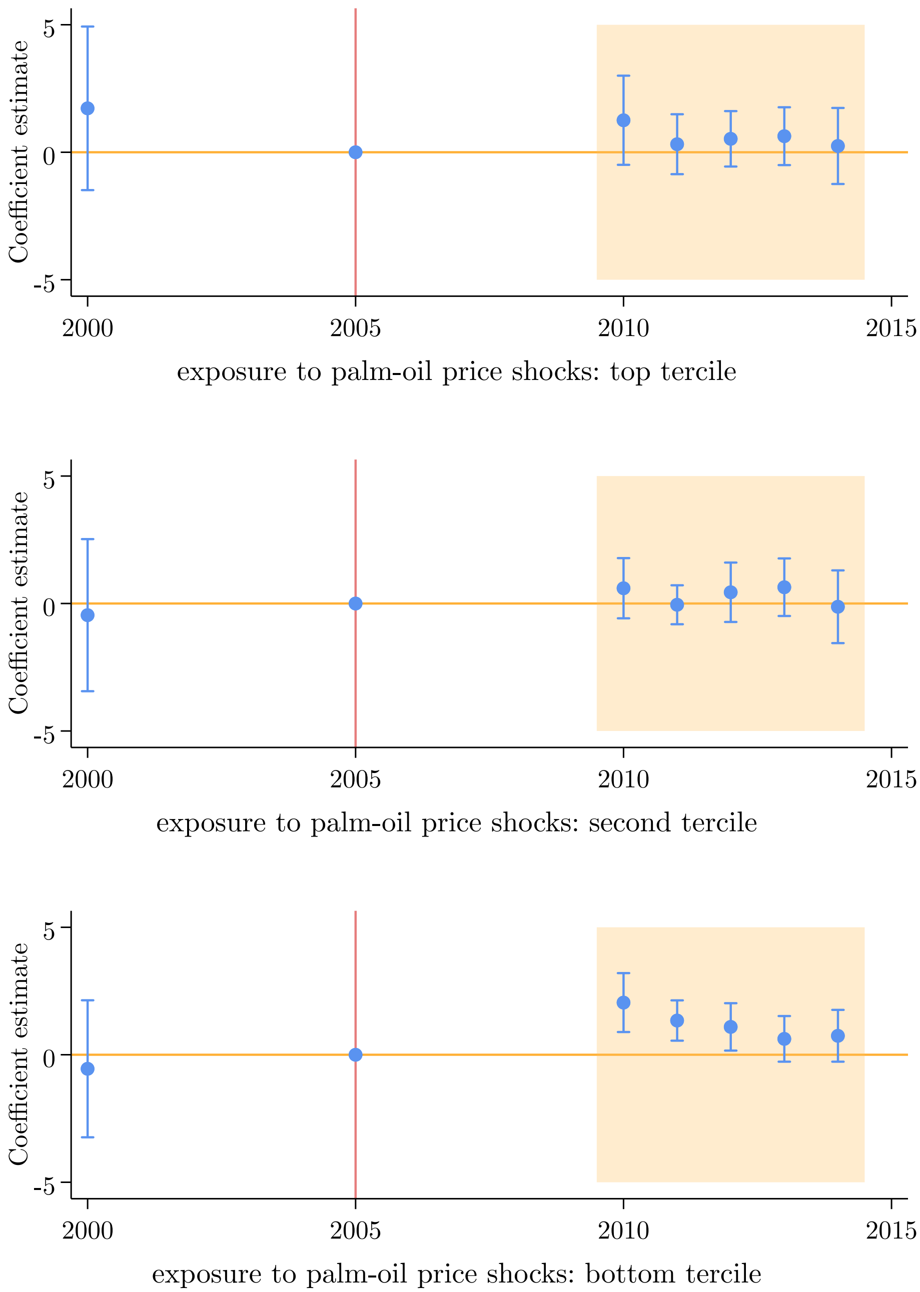
Notes: The dependent variable is the share of net-inward migration. The model includes control variables interacted with year, district fixed effects and year fixed effects. Regression is run on a panel of districts over year. Standard errors are clustered at the district level. Point estimates are relative to the year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

Figure 17: Impact of palm oil price shocks on net-inward migration across terciles



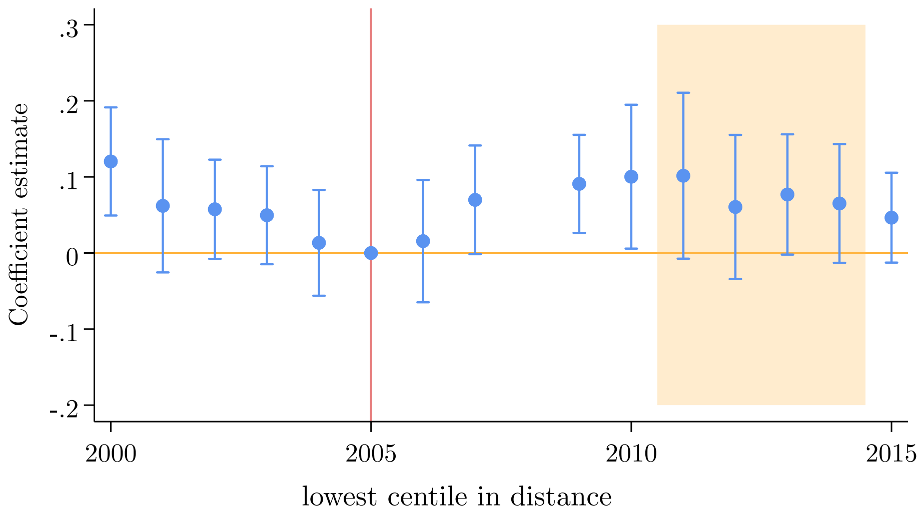
Notes: The dependent variable is net-inward migration. The model includes control variables interacted with year, districts fixed effects and year fixed effects. Regression is run on a panel of districts over year. Standard errors are clustered at the district level. Point estimates are relative to year the 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

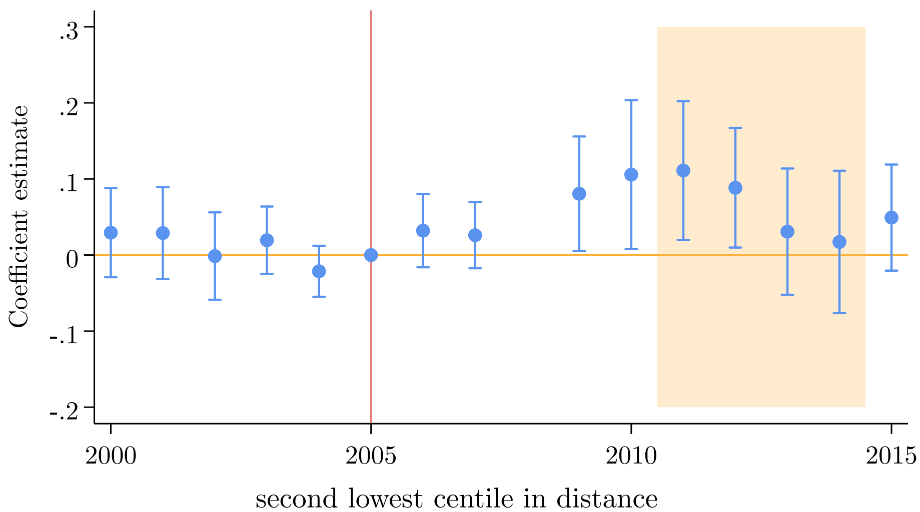
Figure 18: Impact of palm oil price shocks on share of net-inward migration across terciles



Notes: The dependent variable is share of net-inward migration. The model includes control variables interacted with year, districts fixed effects and year fixed effects. Regression is run on a panel of districts over year. Standard errors are clustered at the district level. Point estimates are relative to the year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

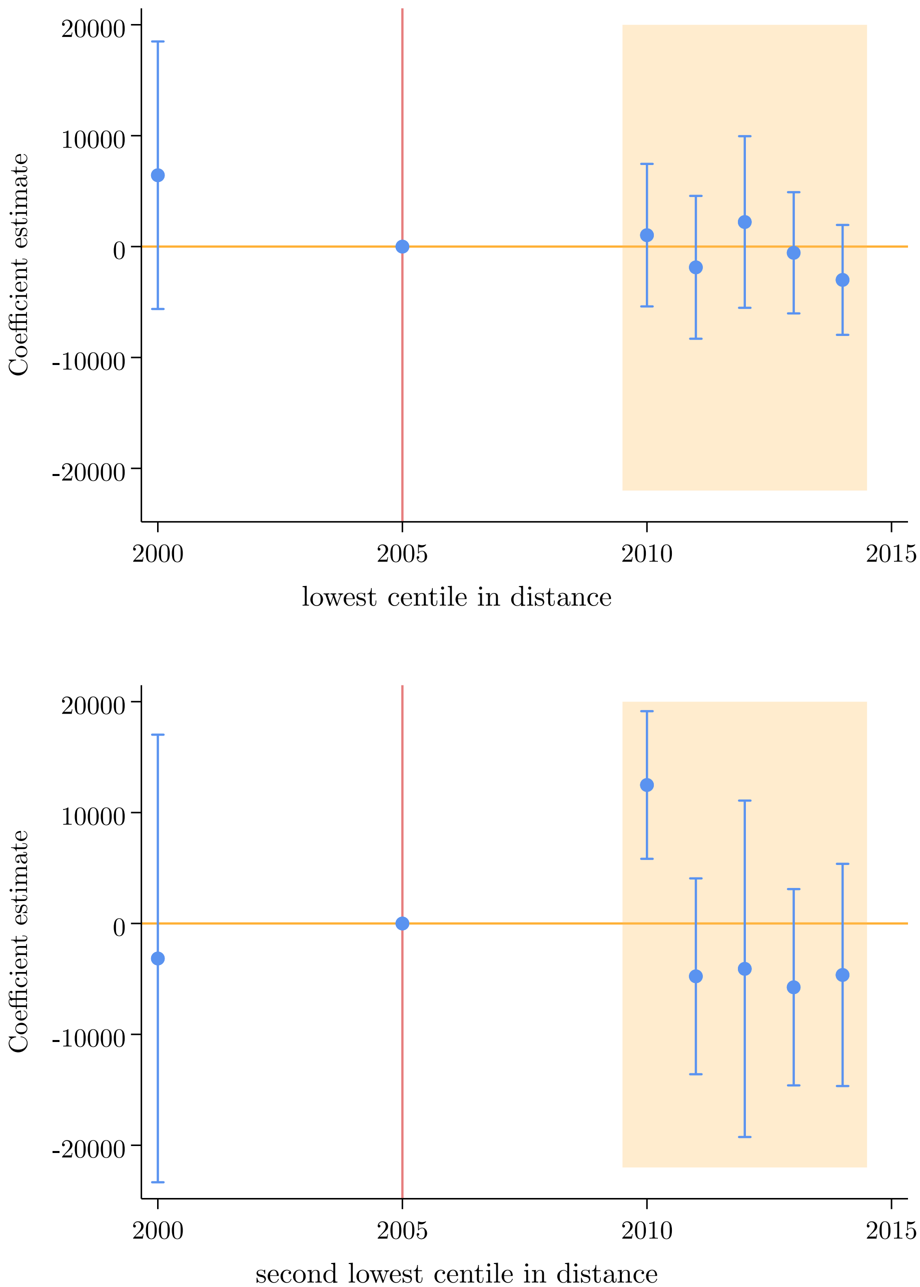
Figure 19: Spillover of palm oil price shocks to nearest non-exposed districts: Real expenditure per capita





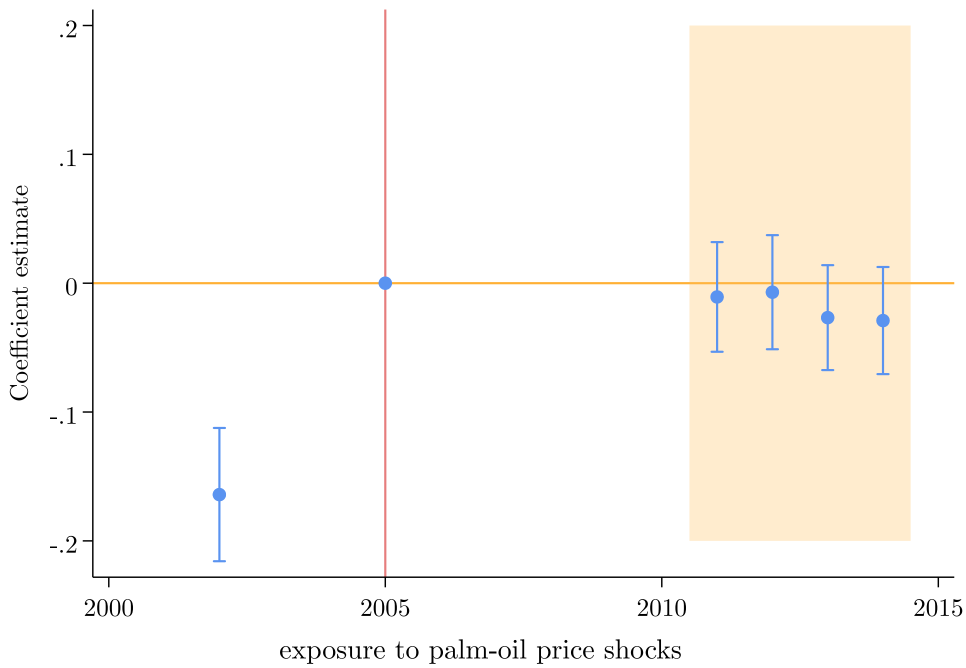
Notes: The dependent variable is (ln) real expenditure per capita. The model includes potential yield of palm oil, status of exposure of rice price shocks, other control variables, districts fixed effects and year fixed effects. Regression is run on a panel of districts that are non-exposed to palm oil price shocks over year. Standard errors are clustered at the district level. Point estimates are relative to the year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

Figure 20: Spillover of palm oil price shocks to nearest non-exposed districts: Net-inward migration



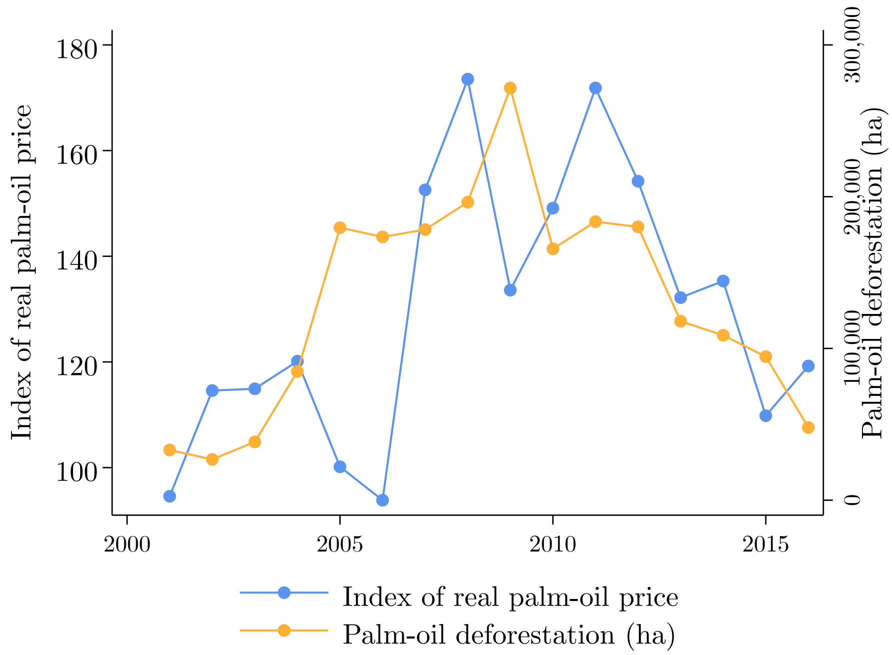
Notes: The dependent variable is the number of net-inward migrations. The model includes potential yield of palm oil, status of exposure of rice price shocks, other control variables, districts fixed effects and year fixed effects. Regression is run on a panel of districts that are non-exposed to palm oil price shocks over year. Standard errors are clustered at the district level. Point estimates are relative to the year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

Figure 21: Impact of palm oil price shocks on district premia



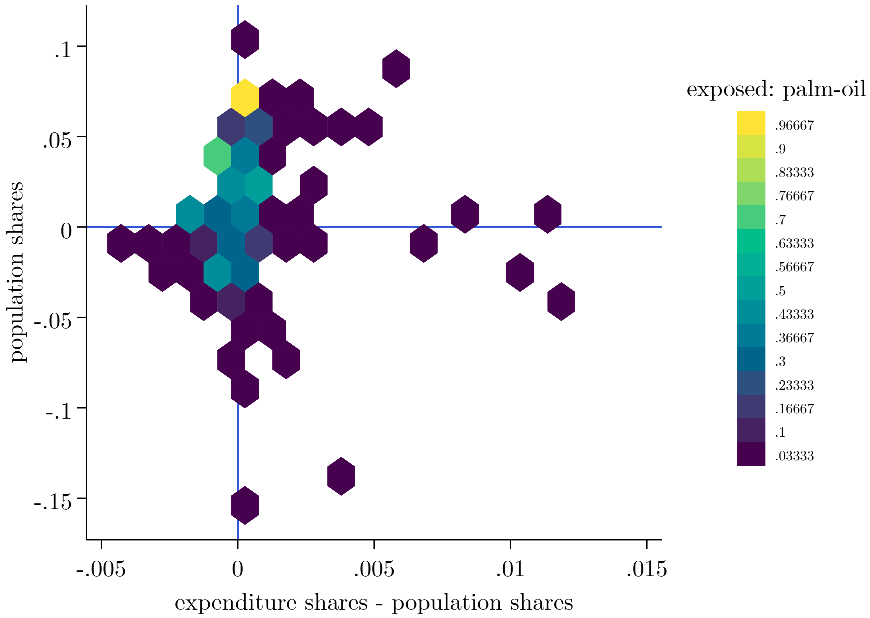
Notes: The dependent variable is the estimated district premia obtained from running Mincerian regressions on real expenditure per capita at the household level. The model includes control variables, districts and year fixed effects. Regression is run on a panel of districts over year. Standard errors are clustered at the district level. Point estimates are relative to the year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows the post-treatment period.

Figure 22: Deforestation driven by palm oil plantation and palm oil price



Source: Table 3 of the Supplementary Materials of Austin et al. (2019) for deforestation data. IMF Commodity price series for world palm oil prices; index calculated by author.

Figure 23: Distribution of drivers of gains from migration by exposure to palm oil price shocks



Notes: Each bin represents a group of districts. The colors of the bins represent the share of districts exposed to palm oil price shocks at each particular bins.

Data Appendix

INDO-DAPOER

This dataset presents various economic indicators disaggregated to the province and district level. The dataset is summarized from different official datasets and compiled by the World Bank. I obtain district-average expenditure per capita as a proxy for regional welfare and local earnings from this dataset. In addition, I also get sectoral GDP, area, and population for each district from this dataset. For each year, I crosswalk districts to the districts defined in 2000.

The control variables in reduced-form exercises are obtained from INDO DAPOER dataset as well. These variables are:

- Percentage of rural population in 2000
- (ln) Regional GDP in mining and quarrying sector in 2000
- (ln) Regional GDP in manufacturing sector in 2000
- (ln) Length of district road in bad condition in 2000
- Percentage of villages with asphalt roads in 2000.

National Socio-Economic Survey (*Susenas*)

This household survey provides the most comprehensive household's expenditure pattern and other social and economic indicators annually for the Indonesian economy. The database is sampled from around 300,000 households and is representative up to the district level. *Susenas* is also the source for INDO DAPOER's data on expenditure per capita. In general, the survey has two sets of questionnaires: the core and the modul. The core questionnaire poses basic economic and social indicators to members of households and households. Before 2011, the consumption modul questionaire was included every three years. In this regard, the matching between the core and modul questionnaires before 2011 can be done for survey years 2002, 2005, and 2008. Given this construction, I estimate district premia only in these years for the pre-2011 period. Nevertheless, due to insufficient representativeness in the invidual matched sample in 2008, I do not include 2008 in the district premia estimation.

Since 2011, *Susenas* has included questions on migration behaviour that were previously only captured every five years using census and between-census population surveys. I constructed a migration flow matrix across districts from these migration questions. Then I compute the recent migration rate per district destination from this dataset. Recent migration is defined as a change of residential location between the survey year and five years prior to the survey year.

Population Census and Inter-Census Population Survey from IPUMS

I obtain past recent migration patterns from the Population Census in 2000. Inter-Census Population Survey 2005 and Population Census 2010 are provided by IPUMS. This dataset is a 10% sample of the complete census and is representative up to the district level.

Prices data

IMF Commodity Price Series I use commodity prices in the IMF Commodity price series as a benchmark for world prices. The benchmark world price for palm oil is the palm oil prices of the Malaysia Palm Oil Futures (first contract forward) 4% to 5% FFA in USD per metric ton. The benchmark world price for rice is the 5% broken milled white rice of the Thailand nominal price quote in USD per metric ton. Since I am using domestic retail prices for rice, I follow Dawe (2008) in adding 20 USD per ton for rice shipping and a 10% mark-up in order to translate the world rice price to the retail price for imported rice in Indonesia.

Retail prices data for rice from BPS Domestic retail prices for rice are available for the main city of each province.

Exchange Rates from FRED I retrieve the monthly USD to IDR exchange rate and Indonesian CPI from the FRED database. I use the exchange rates to convert USD prices into IDR prices. Then I deflate the nominal prices with Indonesian CPI to get real prices.

CPI from BPS National CPI data is obtained from BPS.

Tree Crops and Food Crop Statistics from Ministry of Agriculture

I obtain data on the harvested area for palm oil and rice by district from the tree crops and food crop statistics published by the Ministry of Agriculture. Moreover, I compute actual yield by district using harvested area and production data by district published in these datasets as well. I do not take the yield data directly from this dataset because I want to use the same district definition over time.

FAO Global Agro-Ecological Zones (FAO - GAEZ)

Data on estimated potential yield for palm oil and rice is retrieved from the Global Agro-Ecological Zones by the FAO.[32] For each crop, I take the assumptions on water supply and input level as shown in Table 13 below. I also take the estimated potential yield for the period 1961-1990.

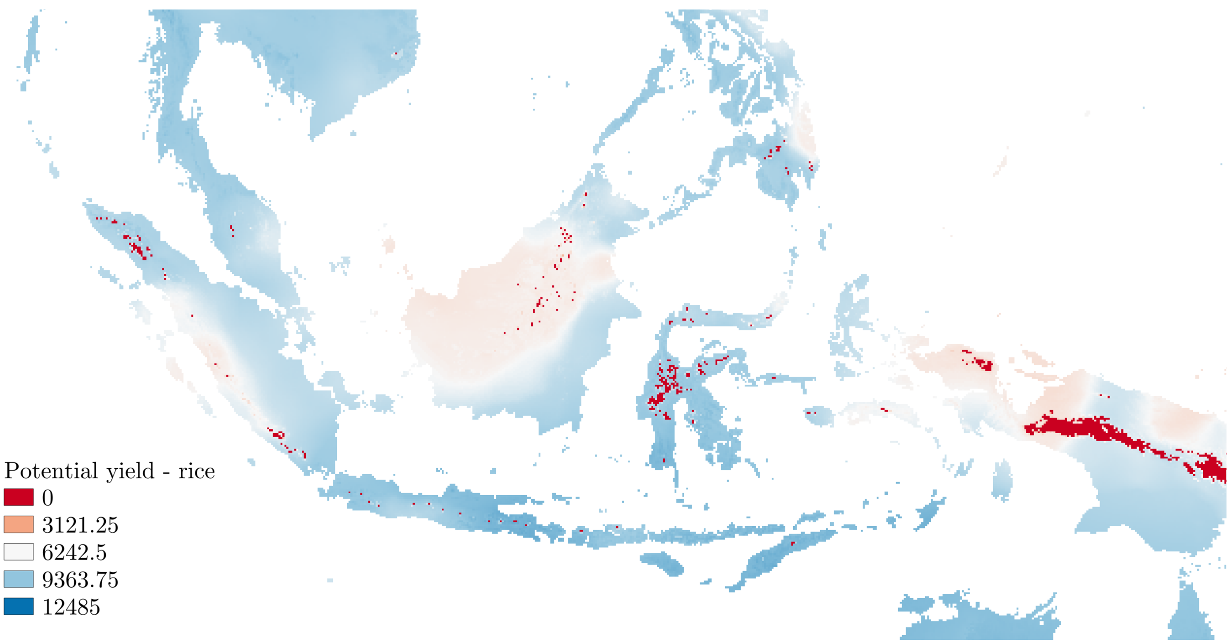
Table 13: Assumptions about water supply and input level

Crop	water supply	input level
Palm oil	rain-fed	high input
Rice	irrigated	high input

[32]Data can be dowloaded here : http://www.fao.org/nr/gaez/en/.

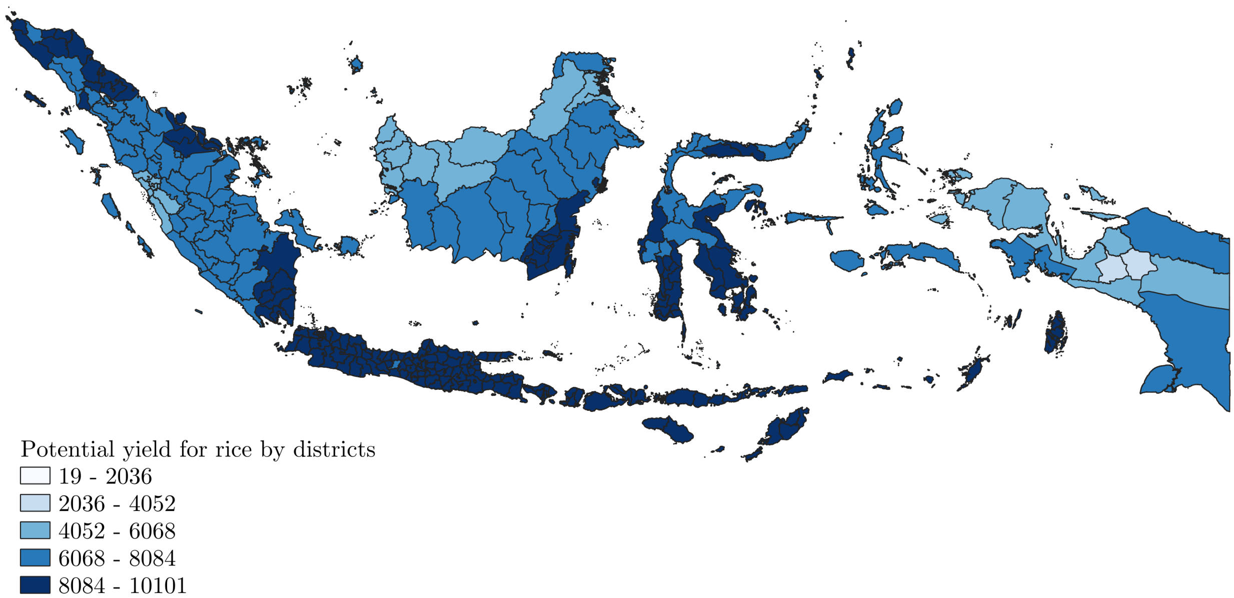
Raw data from FAO GAEZ is presented in a five-grid level raster data. Figure 26 and Figure 24 show the raw potential yield data for, respectively, palm oil and rice in Indonesia and the surrounding area. For district-level analysis in this paper, I take the district averages for each crop. The district average is computed by dividing the sum of the potential yield in each district by the count of pixels overlaid on each district. For districts with less than 1 pixel, I divide the sum of the potential yield by 1 pixel. Figure 25 shows the distribution of the district-average potential yield for rice. Figure 27 shows the distribution of the district-average potential yield for palm oil.

Figure 24: Potential yield for rice in 5-grid level



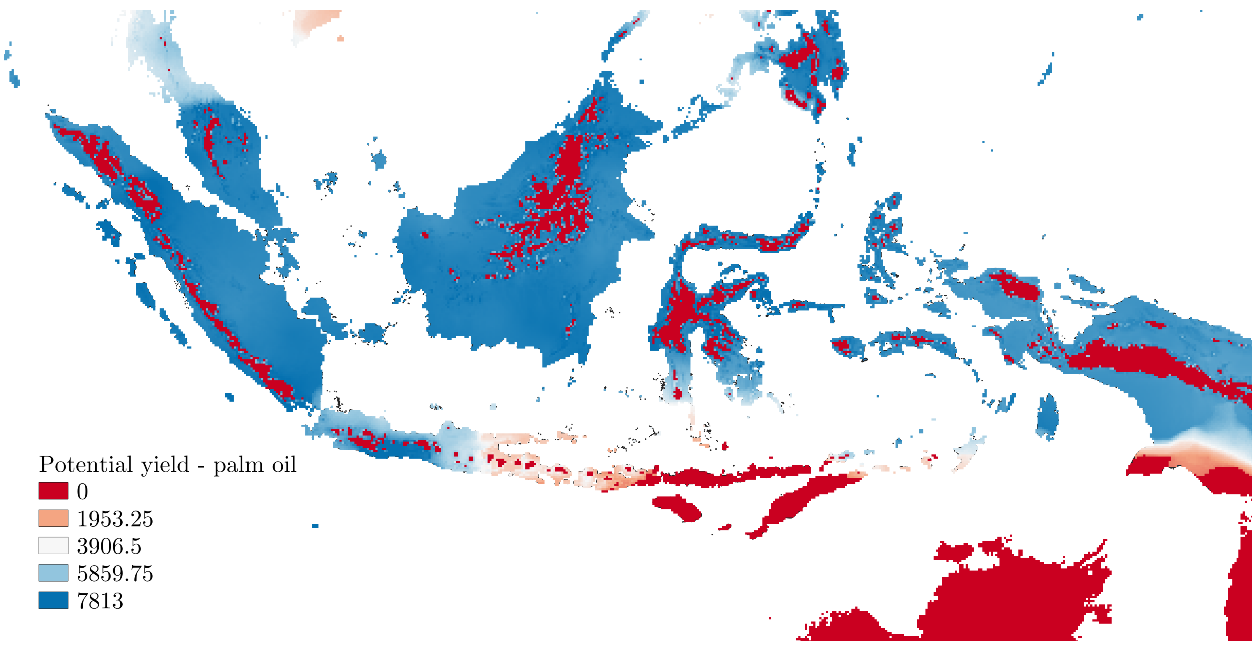
Source: FAO GAEZ.
Notes: Potential yield is in kg DW/ha.

Figure 25: District-average potential yield for rice (kg DW/ha)



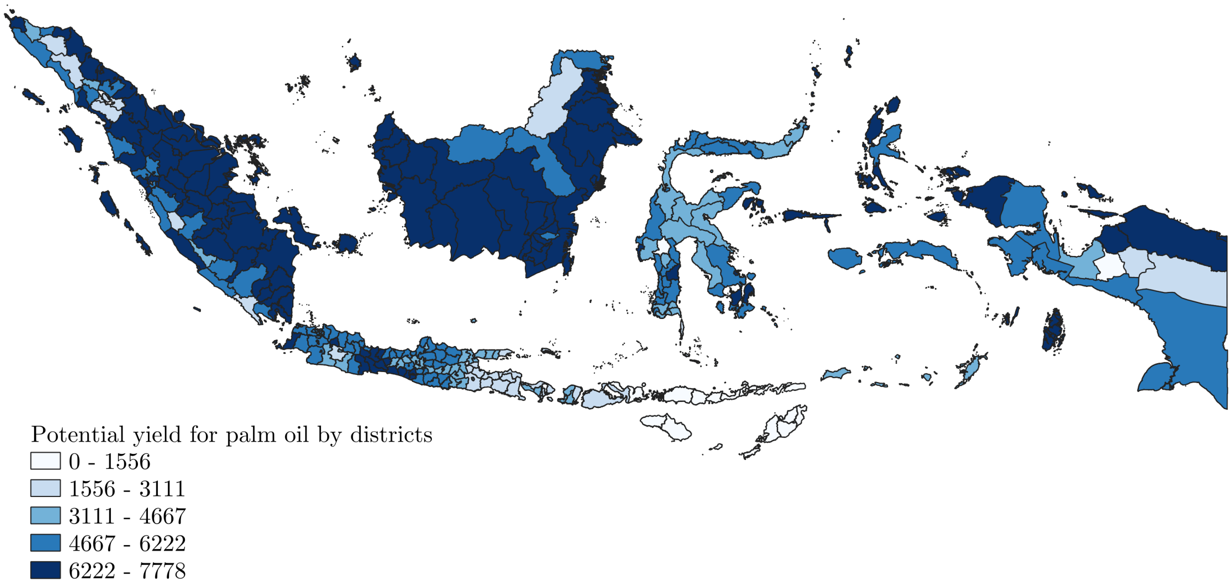
Source: FAO GAEZ, author's calculation.
Notes: Potential yield is in kg DW/ha. Districts use the district definition from 2000.

Figure 26: Potential yield for palm oil in 5-grid level



Source: FAO GAEZ
Notes: Potential yield is in kg DW/ha.

Figure 27: District-average potential yield for palm oil (kg DW/ha)



Source: FAO GAEZ, author's calculation.
Notes: Potential yield is in kg DW/ha. Districts use the district definition from 2000.

Village Census (*Podes*)

Podes is a triannual census covering information about the social, economic and geographic condition of all of the villages in Indonesia. It includes questions on demographics, natural resources, quality and quantity of infrastructure, and other economic variables. I use the 2005 and 2008 census to get measures on observed amenities during the period five years prior to *Susenas* 2011-2014. For each variable of observed amenities, I take the district average using population as a weight. Then, following studies such as Diamond (2016) and Bryan and Morten (2019), I employ Principal Component Analysis (PCA) to get measures of observed amenities. I group various amenities indicators from *Podes* into two types of observed amenities: favorable amenities and less favorable amenities.

Chapter 2

Price divergence in times of trade protection: Exploration on the import ban on rice in Indonesia

2.1 Introduction

Despite the widespread policy reforms and reduction of trade barriers for the past four decades, protective trade policies are still prevalent in developing countries (Atkin and Khandelwal, 2020). Indeed, recent surveys of literature, such as Atkin and Khandelwal (2020) and Goldberg and Pavcnik (2016), reveal that the distributional impact of trade policies in developing countries may not be as straightforward as predicted by the neoclassic trade models due to various frictions. In this chapter, I study the impact of a binding non-tariff trade policy imposed by Indonesia. Despite the relatively stable prices and parallel trend with the world price of rice since the 1970s to early 2000s (Warr, 2005), in 2004, Indonesia introduced a large import ban on rice, a staple food for most of its 260 million population. As expected, domestic retail prices for rice have increased and diverted away from the world price. I find that the rice price shocks did not increase the purchasing power of rice-producing districts, nor did they spur growth in the rice sector. This result may indicate the ineffectiveness of the trade protection to support rice farmers as well as motivate the question on the distributional impact of the trade policy.

This paper aims to explore and document the price divergence that occurs due to the import ban. I find that understanding this phenomenon is first-order in evaluating the trade policy, especially in light of the insignificant impact of the trade protection to benefit the rice-producing districts. I contribute to the literature as the first study that, not only explores price divergence across regions, but also price divergence between retail prices and farm-gate prices. The previous study has shown that there is a parallel trend of the national retail price and national farm-gate prices.[33] However, using more granular data, I am the first to show evidence of incomplete pass-through between retail prices to farm-gate prices of rice. In addition, I explore potential drivers of the wedges between the retail prices and the farm-gate prices, such as search costs, transportation costs, and information costs.

To analyze the price divergence, I build upon various empirical strategies performed by Allen (2014) and Bazzi (2017) in analyzing trade patterns and prices of agriculture commodities. I replicate strategies to identify incentives to arbitrage and the role of search costs as shown by Allen (2014). Meanwhile, Bazzi (2017) explored various empirical patterns of the retail prices of rice in Indonesia during the import-ban policy. I complement his findings using a longer time series of regional retail prices. I also replicate his empirical methods in understanding prices on farm-gate prices.

I document four features of the price divergence during the import-ban policy. First, unlike the case of the Philippines, as shown by Allen (2014), the relative ranking of rice prices persists during the trade-protection era. Indeed, weather, representing time-variant productivity across provinces, has a small contribution in explaining the variation in log real retail and farm-gate prices. Second, provinces with a higher relative rank of both retail and farm-gate prices are the ones with higher (time-invariant) potential yield in growing rice. These two facts indicate that search costs may not be substantial drivers in the lack of arbitrage implied by the price divergence across regions.

Third, I confirm the result shown by Bazzi (2017) that provinces with higher increases in retail prices after the ban are the ones with higher import pass-through elasticity. However, I do not find evidence of such a trend for the farm-gate prices. Lastly, I show that transportation and communication infrastructures have been improving in Indonesia. The

[33] Bazzi (2017).

correlations between several variables representing the use of these infrastructures with retail and farm-gate prices are mostly statistically insignificant. However, there is potential in the role of information frictions as represented by mobile phone use in determining prices in the upstream side of the rice value chain. Farm-gate prices have a statistically significant positive correlation with mobile phone use. This relationship may imply the role of information in empowering farmers to get more competitive prices. The third and fourth facts may indicate imperfect competition in the rice markets as well as other domestic trade frictions such as logistic costs, information frictions, and the role of middlemen. If traders perform strategic behavior especially by charging retail prices that are higher than their competitive level and buying with farm-gate prices that are lower than their competitive level, then the increasing wedges between retail and farm-gate prices as well as the lack of arbitrage are the direct outcomes.

There are at least two implications from the evidence of price divergence and why rigorous evaluation on the trade policy is due. First, Atkin and Khandelwal (2020) suggested that evidence that trade affects not only the magnitude but also the dispersion of markups indicate misallocation issues. Various studies show that domestic misallocation of resources has a substantial contribution to aggregate income differences across countries.[34] Second, understanding what types of frictions present and acknowledging structural issues that affect the distributional impact of trade protection can guide policymakers in evaluating the trade policy and improve policy-making. For example, Bigsten et al. (2004) show that firms in developing countries may not be able to seize economies of scale to be more competitive as they face high trade costs and poverty, which create small and segmented markets for the firm to sell to. In this case, since rice farmers are relatively small in Indonesia, simply opening up the import ban may not directly help farmers to reap growth through economies of scale, let alone to be internationally competitive.

I propose the collection and use of two sets of data in order to rigorously evaluate the

[34]See for example Banerjee and Duflo (2005) and Restuccia and Rogerson (2017).

trade policy. First, I propose to use and collect the data of regional farm-gate prices and grain prices along the rice value chain. This data on prices can substantially contribute to providing a deeper understanding of the distributional impact of the trade policy. Second, I propose to get data on intra-national trade in rice to better understand the lack of arbitrage. So far, such data is not available, at least for the public.

This paper contributes to three strands of literature. First, it contributes to the studies on the impact of trade policies, in particular, in the form of a binding non-tariff barrier. Most studies in this field focus on the impact of trade of liberalization. This paper complements the literature with the impact of de-liberalization as Indonesia moved from a free-trade policy to the imposition of trade protection. Goldberg and Pavcnik (2016) provide a recent survey of literature on the impact of trade policies, while Feenstra (1995) presents the survey for earlier studies. Several studies discuss Indonesia's import ban on rice, such as Warr and Yusuf (2014) and Warr (2011).[35] Relative to these papers, I show that the price shocks due to the import ban did not increase the purchasing power of rice-producing districts. In addition, I show that the import ban creates price divergence across regions as well as between retail prices and farm-gate prices.

Second, I contribute to the literature on the impact of trade policy on prices. As Goldberg and Pavcnik (2016) review, there are only a few papers that focus on prices as the outcome of interest despite their central role in trade policy evaluation. This paper focuses on one particular crop or industry: rice. Such focus allows us to analyze how a trade policy may affect the upstream side of the industry, i.e., as reflected by the farm-gate prices, and the downstream side, i.e., as reflected by the retail prices, differently. Previous works that study the impact of trade policy on prices include Topalova (2010) and De Loecker et al. (2016). Both papers study the impact of trade liberalization in India and find that increase competition leads to lower prices. Echoing their finding, I find that retail prices and farm-gate prices increase due to the absence of import competition. However, the retail prices

[35]Other studies, such as Bazzi (2017) and Sim (2020), use the price shocks due to the import ban as sources of income shocks.

increase more than the farm-gate prices.

In addition, I show that the increase in retail prices is not passed on completely to farm-gate prices. There is substantial variation across regions in terms of the wedges between retail prices and farm-gate prices. These wedges can consist of, not only value-added for mills and trade frictions but also markups of traders. In terms of the impact on markups, previous studies do not show a conclusive impact of competition on markups. For example, Levinsohn (1993), Harrison (1994), and Edmond et al. (2015) show that markups decreased with trade liberalization policies, while De Loecker et al. (2016) find that the markups actually increased in the trade liberalization episode in India. In this paper, I provide motivation to study the impact of the import ban on markups, including the importance of considering frameworks with variable markups, as part of a rigorous trade policy evaluation.

Lastly, this paper contributes to the literature on trade frictions in developing countries. Atkin and Khandelwal (2020) provides a comprehensive survey of literature on this topic. Exploring the increasing wedges between retail and farm-gate prices as well as the regional price divergence due to the import ban on rice, I provide insights on the potential contribution of imperfect competition and domestic trade frictions including the role of middlemen in intra-national trade in a developing-country context. Studies on imperfect competition in trade intersect with studies on the impact of trade policy on markups as mentioned above. Meanwhile, studies on the role of intermediaries in developing countries, such as Atkin and Donaldson (2015), show the prevalence of intermediaries and find that remote locations hurt the most due to the interaction of high trade costs and lack of competition among intermediaries. Dhingra and Tenreyro (2020) and Bergquist and Dinerstein (2020) show the role of traders' market power in explaining the degree of price pass-through.

The paper is organized as follows. I describe the trade policies related to the import ban on rice as well as the impact of the rice price shocks due to the import ban in Section 2. I continue in Section 3 with empirical exploration in understanding the spatial price divergence during the import ban. I discuss the implications of the findings from the exploration in

Section 4. Lastly, in Section 5, I provide the conclusion.

2.2 The import ban on rice in Indonesia

2.2.1 The political economy of rice in Indonesia

Rice is an, if not the most, important agricultural commodity in Indonesia. It is the main staple food for most Indonesians. The national household survey in 2007 shows that poor households spends on average 22% of their total expenditure on rice, or approximately one-third of their food expenditure (Aldaz-Carroll, 2010). Meanwhile, rice sector is also a major employer. The agriculture census in 2003 reveals that 55% of agriculture households in Indonesia are rice farmers. However, only 6% of those have control over more than 0.5 ha of rice fields (McCulloch, 2008). Since rice is a necessity to most Indonesians, an increase in its prices may reduce purchasing power to net consumers.

Given the strategic position of rice in the economy, rice policy has been closely determined by the political situation as well.[36] Since the early 1970s to the late 1990s, rice price stabilization was achieved through imports. Particularly, the national logistic agency (Bulog) was given a mandate to stabilize rice prices. The government also provided Bulog with import monopoly. Then, in the short period after the Asian Financial Crisis (AFC), Bulog lost its authority as the sole importer of rice as part of the IMF policy package that Indonesia took. During this time, rice price stabilization was achieved through imports by private traders (McCulloch and Timmer, 2008). Nevertheless, throughout these periods, real rice prices were relatively stable (Fane and Warr, 2008). Due to the trade liberalization in late the 1990s, Indonesia became the world's largest rice importer (Warr, 2011).

Meanwhile in the early 2000s, as Indonesia recovered from the AFC, pressure to protect rice farmers increased as well. Some import restrictions were imposed in the form of import

[36] McCulloch and Timmer (2008) provide a summary of the political economy of rice in Indonesia from the 1970s to 2008. There is not much changes in terms of policy since 2008 up to the current period.

tariffs. Fane and Warr (2008) estimated that the nominal rate of protection on rice increased from 14% in 2000 to 33% in 2003. Finally in 2004, the Indonesian government placed a ban on imports of rice by the private sector. This ban is supposed to be a seasonal ban to avoid flood of imports during harvest seasons. Some imports are allowed with the size of the quota to be determined by the government. The imports can only be conducted by Bulog.[37] Marks (2017) estimates that in 2015 the nominal rate of protection and effective rate of protection in rice sector reached consecutively 67.2% and 204.3%.

Figure 28 illustrates the trend of Indonesia's exports, imports, and net-export for rice over the various rice trade regimes. In most years between 1990 to 2018, Indonesia is a net-importer of rice. In the period before 1998, Bulog conducted the imports with the objective to stabilize domestic rice prices. In the short period of relatively free-trade of rice in 1998 to 2003, imports were conducted by private traders. Meanwhile, since the import ban in 2004, imports are conducted by Bulog when the governnment decides to import and how much to import. Imports can only be done during off-harvest periods.

Figure 29 shows that since the import ban took place in 2004, domestic rice prices have surged. In addition, discrepancy between domestic prices and the price of imported rice has increased ever since, with some period of reversal during the Food Crisis 2008. Except for the Food Crisis period, the import ban is practically binding as there is lack of incentive to export due to lower prices in export markets. Meanwhile, during the Food Crisis period, the government introduced an export ban on rice to shield the country from the exorbitant level of world prices fueled by export restrictions from main rice exporters and other trade distortion measures.[38] Despite how the import ban has continued to be binding, leading to

[37]These trade policies on rice are stipulated by Minister of Industry and Trade Regulation No. 9/2004, Minister of Trade Regulation No. 12/2008, and Minister of Trade Regulation No. 19/2014.

[38]Various studies show that the price hikes in food commodities during the Food Crisis 2008 were magnified by trade measures. These studies include Giordani et al. (2016), Anderson and Martin (2011) and Bouët and Debucquet (2012). Giordani et al. (2016) in particular document that there were six countries imposing export restrictions or import promotion measures on rice during this period. These trade measures covered 35.72% of world rice trade. For the timeline of enactment of export restrictions and other trade measures on rice see Aldaz-Carroll et al. (2010) and Headey (2011).

a lack of incentive to export, the export bans remain in place.[39]

Another observation that we can see in Figure 29 is that price variation across provinces increased after the enactment of the ban. Before the ban, variation of rice prices across provinces are relatively negligible. This fact may indicate lax arbitrage across provinces after the ban started. There are several plausible reasons that have been proposed in the literature. First, Bulog may have a weaker role and or resources to stabilize domestic prices (Sim, 2020). Second, there was a disruption of trade relationship between private importers and international source markets that were built during the more liberal period of the late 1990s to 2004 (Bazzi, 2017). Third, Warr (2005) estimates that the elasticity of supply is 0.2 to 0.4. Despite the variation across regions, this elasticity is relatively low, especially compared to the elasticity of demand for rice imported from Thailand that ranges between -2.5 to -5.

2.2.2 The impact of rice price shocks

The empirical works in Chapter 1 study the impact of price shocks on two crops: palm oil and rice. Here, I present the results for the impact of rice price shocks due to the import ban.

Districts exposed to rice price shocks did not enjoy higher real expenditure per capita compared to the non-exposed districts relative to the base year. Figure 30 plots the estimated β_{ir}s and their respective 95% confidence intervals for the rice price shocks from running Equation 28 in Chapter 1. Throughout the post-treatment period, the impact of rice price shocks on real expenditure per capita is not significantly different than zero, i.e. the trade protection on rice has not materialized as an increase in purchasing power to rice-producing districts.

Since rice is a staple food for the population in Indonesia, one may suspect that real

[39] In the period of study, export ban on rice is stipulated by Minister of Trade Regulation No. 12/2008 and Minister of Trade Regulation No. 19/2014.

benefit of the trade protection would be captured by main rice producers. In order to investigate this, I run equation 29 to study any heterogeneity in the impact of rice price shocks. Figure 31 plots the coefficients of impact of rice price shocks across terciles. It shows that districts with the most exposure to rice price shocks did not experience higher real expenditure per capita due to the trade protection.

To see whether the rice price shocks affect agriculture and non-agriculture households differently, I run the main specification on the real expenditure per capita of agriculture households and non-agriculture households. Figure 32 plots the coefficients on rice price shocks and their 95% confidence interval. Confirming the previous results, districts exposed by rice price shocks, on average, do not have a significant difference from the non-exposed ones in both agriculture households and non-agriculture households. This is an interesting result as agriculture households, who can represent rice producers, also did not gain from the higher rice prices.

These results imply that if the import restriction was intended to provide stimulus to rice producers, the policy seems to be ineffective. Since most of rice farmers are small in terms of scale, they may not be able to easily expand despite having the binding trade protection. Meanwhile, as they are also part of the consumers of rice, so the increase in rice prices may not increase their purchasing power by much.

2.2.3 No sign of extensification or intensification

Rice crops did not show any sign of extensification nor intensification. Table 15 in Appendix 2 and 9 on Chapter 1 show the coefficients on consecutively harvested area and actual yield for rice. The empirical evidence discussed in detail above show that the rice price shocks did not materialize as stimulus for rice producers. Hence, we also see that there is no indication for investment on land expansion nor increase in yield for rice.

Rice farmers are mostly small-scale. Only 6% of rice farmers have land of at least 0.5 ha. Hence, the increase in rice price may not have benefited rice farmers because it did not necessarily increase their real income and they may not have had enough collateral to get financing for expansion. This result provides some evidence on ineffectiveness of the trade protection on rice in either providing increase in earnings to rice farmers or stimulating the production of rice. In addition, if there is incomplete market problems faced by rice farmers, e.g. financial markets and insurance market, trade protection may not be the appropriate second-best policy to provide assistance to rice farmers.

So far I assume that trade costs and mark-up margins between retail rice price and farm-gate rice price do not change over the period of study. However, if the wedges between retail provincial rice prices and farm-gate prices vary over time for example due to increasing market power of intermediaries, then the trade protection may exacerbate the problem as farm-gate prices may not increase as much as the retail prices.

2.3 Exploration on price divergence

Figure 29 clearly implies the lack of arbitrage across regions during the import-ban period. The spatial divergence of retail prices of rice also seems to widen over time. In this section, I attempt to explore the various potential source of price divergence. I explore not only the provincial retail prices but also the provincial farm-gate prices. In fact, this is the first paper to document spatial and temporal variation in the wedges between retail and farm-gate prices of rice as an effort to evaluate the import ban policy.

2.3.1 Data

Retail prices Retail prices data is obtained from BPS-Statistics Indonesia (BPS). These prices are available for the capital city of each province. The panel of provincial-level retail prices is relatively complete. I include monthly prices from January 1993 to December 2017.

Farm-gate prices BPS collects several types of paddy and grains prices before the rice is sold to consumers.[40] I particularly use the prices for harvested paddy as farm-gate price. Monthly province-level farm-gate prices are obtained from the Statistics of Producer Prices for Paddy (*Statistik Harga Produsen Gabah*). Unfortunately, this publication is not available every year. For the period before the import ban, data is available for the year 2003. In the period of the import ban, data is available up until 2018 with some gaps.[41]

Rainfall Monthly rainfall data is obtained from the Global (Land) Precipitation and Temperature, University of Delaware. Specifically, I take the Terrestrial Precipitation (V 4.01) that provides monthly rainfall up to the year 2014. I take the provincial averages for each month-year.

Crop suitability I use the potential yield estimated by the FAO from its GAEZ dataset as crop suitability. This variable is a single measure. I take the provincial averages of this measure.

2.3.2 Trend of retail prices and farm-gate prices

Do farm-gate prices proportionately increase with retail prices during the import-ban period? The answer to this question in the literature has been scarce. Bazzi (2017) shows that the national-level retail prices and farm-gate prices moved in parallel for the period of 2000 to 2008. This paper provides the first attempt to answer this question with more granular price data.

Figure 34 compares the trend of provincial retail prices and provincial farm-gate prices. We can infer two facts from this figure. First, nominal farm-gate prices have generally increased over time. However, the increase in retail prices seems to be steeper than the increase in farm-gate prices. These two facts imply that the ratio of retail prices to farm-

[40]Figure 33 illustrates the rice value chain and the various types of prices.
[41]See Table 14 in Appendix 2 for details.

gate prices or I define here as "wedges" of rice prices, have increased. These wedges include several margins such as the value-added for paddy mills, transportation costs, and other trade costs, as well as traders' profit margin. Figure 33 illustrates the rice value chain from paddy grown by farmers to rice consumed by consumers. Using the ratio of the retail price and farm-gate price as wedges, we can observe from Figure 35 the range of wedges across provinces has widened over time.

We can also see the wider ranges of wedges of rice prices in Figure 36, which depicts the trend of retail prices and farm gate by province. Provinces differ in terms of the evolution of wedges over time. In general, farm-gate prices increase during the import-ban period. However, provinces vary in the relative increase of their retail and farm-gate prices with virtually no province have a decreasing wedge between its retail price and farm-gate price.

I follow Allen (2014) in evaluating the persistence of the ranking of relative price. In the case of crops in the Philippines, Allen (2014) shows that the correlation of relative ranking decreases over time. It means that provinces do not always have high or low relative prices compared to other provinces. In his case, such a condition indicates high search costs for farmers since it is hard to predict which provinces offer higher relative prices at any given period.

In contrast, for the case of rice prices in Indonesia, correlations of relative ranking have stayed relatively high especially post-2004 or as the import ban is in place. Figure 37 shows, before 2004, the darker colors imply that relative ranking at a given period of time has a low correlation with relative ranking in the previous five years or more. However, after 2004, the correlations of relative ranking across periods, including between five to 10 years span, remain high as indicated by the lighter colors. In other words, provinces with a high relative ranking of retail prices persist to have high relative rankings. Such conditions may indicate that search costs have a weaker role in explaining the lack of arbitrage across provinces.

2.3.3 Prices and crop suitability

To analyze which provinces have the higher relative ranking in prices and which have lower, Figures 38 and 39 plot the empirical cumulative probability of the retail price distribution and farm-gate price distribution with each province's crop suitability in growing rice. For both retail and farm-gate prices, provinces with higher relative rankings in prices tend to have lower crop suitability. This fact reflects that such provinces are more supply-constrained. Meanwhile, provinces with lower rankings in prices have higher a potential yield in rice, reflecting their superiority as rice-producing districts. Such regularity has been more prominent during the import-ban period. Before 2004, there were more instances for provinces in red, i.e., those with lower crop suitability in rice, to have a lower relative ranking at prices. Yet, such incidence is rare post-2004, implying the lack of arbitrage during the import-ban era.

2.3.4 What contribute to the variation in prices

The spatial price divergence that we can see in rice prices during the import ban may be driven by time-variant local productivity. The intuition is that as the import ban is binding and there is a lack of arbitrage across regions, local prices are even more determined endogenously by time-variant local productivity such as weather. However, variance decomposition of neither log of real retail prices or log of real farm-gate price can strongly support this argument.

The Shapley-Shorrock decomposition[42] for the variation in the log of real retail prices reveals that for the period of 1993 to 2014, only 1.27% of the variation of predicted log real retail prices can be explained by monthly rainfall, which represents time-variant local productivity. Meanwhile, as shown in Table 16, time-invariant location-specific variation, and aggregate time fixed effects variation consecutively explain 19% and 80% of the variation in predicted log real retail prices.

[42]See Shorrocks (2013)

One may predict that time-variant local productivity may be more prominent during the import-ban era. However, the Shapley-Shorrock decomposition on log real retail prices for the period 2004 onwards shows that monthly rainfall only accounts for 0.89%, which is an even smaller contribution compared to the whole period of study, of the variation in predicted log real retail prices. On the other hand, the contribution of the time-invariant province fixed effects (FEs) increases to 24%. Such a result may imply that, indeed, prices are determined more locally. But also, there is strong persistence in location-specific price variation during the import-ban era.

One may suspect that local weather has a bigger role in determining local farm-gate prices. Table 17 presents the results of the Shapley-Shorrock decomposition for log real farm-gate prices. Since data on farm-gate prices are less complete, especially for the period before the import ban, we should put more cautious in taking the results. In general, two main patterns we see in the decomposition of retail price are also present here. First, local weather has a relatively low contribution in explaining the variation in log real farm-gate prices. For the period of 2005 to 2012, weather contributes 0.15% of the variation in predicted log real farm-gate prices. Second, there is a substantial contribution from location-specific factors. In particular, for the period of 2005 to 2012, province FEs account for 39% of the variation in log real farm-gate prices.

These results stand in contrast with the results shown by Allen (2014) for the case of multiple crops in provinces in the Philippines. He finds that weather represented by monthly rainfall contributes to 13.48% of the variation of predicted log real prices. Meanwhile, time-invariant province FEs and the aggregate time FEs explain consecutively 39% and 47%. In the context of the Philippines, the prominent role of weather contributes to the inherent search costs.

2.3.5 Price behavior after the import ban

Bazzi (2017) rationalizes the lack of arbitrage across regions by adapting a formulation of the national rice price changes as in Warr (2008) by allowing relevant parameters such as import pass-through elasticity to vary across regions. The theoretical framework shows that, with a binding import ban, regions with higher import pass-through elasticity experience larger price increases. He shows that distance to the main rice exporters such as Bangkok port and Ho Chi Minh City port can represent the regional variation in import pass-through elasticity. In this case, regions with lower distances have higher import pass-through elasticity. He confirmed the theoretical prediction that distance to these ports after the ban is associated negatively with provincial log real retail prices in rice. I ran his estimation strategy using a longer time series of the log of real retail prices of rice. Table 18 shows that I confirm the same results. I find that provinces with lower distances are associated with higher log real retail prices during the import-ban era.

To push the analysis further, I run the same estimation strategy on the log of real farm-gate prices. If trade costs and mark-up rate between retail price and farm-gate price do not change over time, regional import pass-through elasticity for farm-gate prices should be the same as their respective elasticity for retail prices. In such a case, the coefficient for the interaction between distance to Bangkok and Ho Chi Minh City ports should also be negative during the import-ban period.

Table 19 shows that the theoretical prediction does not hold for farm-gate prices. Distance to the import origin ports has a positive association with the log of real farm-gate prices. In other words, regions further from Bangkok and Ho Chi Minh City, i.e., regions with lower import pass-through elasticity, tend to have higher farm-gate prices. Such a condition implies that trade costs matter more than exposure to import competition for the upstream side of the rice value chain.

In addition, I confirm what Bazzi (2017) also finds that retail prices moved in lockstep as the import ban took place. On Table 18, the coefficient for Post-2004 fixed effect is positive and significant. Unfortunately, due to the lack of data points before 2004, I cannot study such price behavior for the farm-gate prices.

2.3.6 Have trade costs increased over time?

Perhaps the increase in the wedges between retail prices and farm-gate prices reflects increasing trade costs. This case may happen for example due to worsening transportation infrastructure. In addition, lack of arbitrage may occur due to bad quality or lack of communication infrastructure. For example, as Allen (2014) shows in the case of agriculture trade in the Philippines, the use of mobile phones reduces information frictions. These frictions reduce the intensive margin of trade, hence it may explain the lack of arbitrage as well.

In the case of Indonesia post-2004, transportation infrastructure has been growing across provinces. Figure 40 presents the proportional increase of the length of roads by province between 2010 and 2015. All provinces have increased more than 50% of their total lengths of roads in 2010 by 2015. Of course, this measure does not reflect whether there is any improvement in the quality of the road. Table 20 provides the correlation of the (log) length of roads and both (log) real retail prices and farm-gate prices. The signs are negative, as expected, i.e., the increase in length of roads may represent lower trade costs, hence correlates with lower prices. These correlations are not statistically significant, which may reflect the lack of variation in the growth of the length of roads across provinces and years and thus may not be an important driver of the variation of prices.

Meanwhile, Figure 41 depicts the increase in mobile-phone uses and internet uses across provinces. There are some variations in how much these measures increase but in general, all provinces experience growth in the use of communication infrastructure. Table 21 presents the correlations of mobile-phone use and internet use with retail prices and farm-gate prices. Neither mobile-phone use nor internet use has statistically significant correlations with (log) real retail prices. However, mobile phone use has a positive and statistically significant correlation with (log) real farm-gate prices. This correlation should not be taken as a causal relationship as it may reflect provinces with higher mobile-phone use as more affluent hence prices are higher. However, it may also imply higher use of mobile-phone as lower information frictions, which allow farmers to get access to information about prices in other regions. Such information may empower farmers to get more competitive farm-gate prices.

In general, we see the growth of both transportation and communication infrastructure. There is some indication that information frictions may have a role in the upstream of the rice value chain. However, it seems it is hard to find evidence on increasing trade costs as a driver of the lack of arbitrage across rice markets.

2.4 Discussion

Assuming that there is a complete pass-through of retail prices to farm-gate prices, I show that the import-ban on rice did not increase the purchasing power of the main rice-producing districts. I then continue the analysis with exploration on what drives the price divergence during the import-ban era to shed light on whether the assumption of the complete pass-through between retail prices to farm-gate prices is supported by data. Here, I discuss four points that we can draw from exploring the price divergence.

First, there is persistence in the relative rankings of retail prices and farm-gate prices. In other words, information on where prices are high can be learned easily as the rankings do not vary much during the trade protection regime. In particular, provinces with high potential yield in producing rice are the ones with lower relative rankings. Since the import ban takes its effect, this pattern persists even stronger. This persistence in the relative rankings stands in contrast with the case of substantial information frictions in the intra-national trade of agriculture commodities in the Philippines as shown by Allen (2014). In that case, since relative rankings do not persist over time, farmers and traders face substantial search costs to find where to sell or from where to buy at any given time. In the case of rice in Indonesia, since we see relative rankings of price do not change much over time, we can expect that search costs to be less substantial compared to the case of the Philippines.

Second, time-invariant and location-specific attributes have large contributions to the variation in both retail prices and farm-gate prices. In addition, time-variant local productivity driven by weather only accounts for small variations in prices. Hence, local production does not vary much by weather conditions. Together with the first point above, this fact emphasizes that there are substantial incentives to do arbitrage across regions.

Third, as shown by Bazzi (2017), retail prices increase more in provinces with a higher elasticity of import pass-through. However, I do not find such regularity in the farm-gate prices. The combination of the negative association of distance to ports with retail prices with the positive association of distance to ports with a farm-gate price may be one of the drivers of increasing and spatially diverging variation in the wedges between relative prices and farm-gate prices. In addition, such conditions may contribute to incomplete pass-through of increases in the retail prices to farm-gate prices as we observe from the trend of retail and farm-gate prices by province. Any increase in retail prices is not followed by a proportional increase in farm-gate prices during the import-ban period.

As illustrated by the rice value chain in Figure 33, there are many intermediaries between rice farmers and consumers. They include transportation services providers, warehouse owners, millers, wholesalers, to retailers. They may also benefit from trade protection. In the world of perfect competition, any additional intermediaries add the wedge between upstream and downstream prices. However, literature shows that if the industry is characterized by imperfect competition, it is not as straightforward, who gains a bigger percentage of the rents without knowing the market power of each component in the value chain. For example, McMillan et al. (2002) show that farmers did not enjoy much of the increase in prices as they start to export because the middlemen did not pass through the price increase. Meanwhile, the ease of collusion between traders may matter too. Bergquist and Dinerstein (2020) show that experimentally adding new traders does not reduce retail prices as traders jointly maximize profits.

Fourth, Indonesia has been growing in terms of both transportation and communication infrastructure. It is less likely that trade costs in the form of transportation costs or communication costs to worsen during the period of the import ban. However, there is potential in how the variation in the improvement and use of transportation, as well as communication infrastructure, affects the lack of arbitrage across rice markets. These factors should be taken into consideration in explaining the cause of the price divergence. In addition, since we observe a positive correlation between mobile-phone use and farm-gate prices, there is an indication that information frictions and the role of information in increasing outside options for farmers have a more substantial role in the upstream side of the rice value chain.

In addition to the four points above, the spatial price divergence may also be policy-driven. In 2005, the government started to regulate the rice price stabilization mechanism by allowing local governments to propose provisions of stabilization measures in the face of regional price hikes. Once such a proposal is approved by the central government, Bulog performs the stabilization program of open market operations in the concerned region. The general procedure remained in place until 2018.[43] Since price hikes are reported from a local government to the central government, there may be silos in observing provincial rice prices and thus less attention to the price variation across regions.

Another policy-related aspect that is still missing in this exploration is the role of the state-owned logistic agency: Bulog. Bulog is given the authority to deliver the government's floor price regulation for farm-gate prices. As mentioned above, Bulog also conducts open market operations to tame any price hikes in the retail markets. Future evaluation on trade policy evaluation should take into account the variation in Bulog's intervention across regions and time.

For the purpose of future studies and evaluation of the trade policy, I would like to propose several data that researchers and policymakers should collect and analyze. First, more granular data on grain prices and value-added creation along the rice value chain can better capture the sources of the variation of wedges between retail and farm-gate prices across markets. For example, the Central Statistic Agency (BPS) does not survey the prices

[43]Rice price stabilization with local government alert mechanism is regulated by Minister of Trade Regulation No. 22/2005 and then Minister of Trade Regulation No. 1/2012. The mechanism changed in 2018 under Minister of Trade Regulation No. 127/2018.

of grained ready to be milled at mills. Rather, they estimate the transportation costs from farmers to mills and add the costs to the price of harvested paddy to get the grain prices at mills. Atkin and Khandelwal (2020) suggests that future studies on the impact of trade frictions that focus on a specific industry can contribute high value to the literature. Such studies can provide a deeper understanding of the anatomy of costs, production functions, and markups. Policymakers with an interest to improve the effectiveness and efficiency of the trade protection should prioritize collecting and providing such data for analysis. As we explore here, retail prices and farm-gate prices have not moved in parallel during the trade protection regime. Thus, if the trade protection aims to support or incentivize farmers, then regional farm-gate prices and grain prices along the rice value chain are the statistics that provide better information on whether the goal is achieved or not.

Second, performing pass-through tests on prices between trading provinces would be another first-order attempt to understand the price divergence. Unfortunately, I cannot perform such tests as intra-national trade data is not yet available. Hence, future research on this topic as well as effort in evaluating the trade policy rigorously will benefit from the availability of such trade data. Using intra-national rice trade data we can also study whether there is any strategic behavior performed by traders. The theoretical framework employed by Bazzi (2017) assumes that traders and farmers do not engage in any strategic behavior. If the assumption does not hold, traders facing downward-sloping demand for rice would set retail prices above their competitive level. Meanwhile, traders facing an upward-sloping supply of rice would set farm-gate prices below their competitive level. The two forces may widen the wedge of the retail price and farm-gate price in the form of an increase in markup. This case can explain simultaneously the spatial price divergence and the incomplete pass-through of retail price to farm-gate price.

2.5 Conclusion

Indonesia imposes a large and ongoing import ban on rice, a staple food for its 260 million population. This binding import restriction, which started in 2004 and was followed by an export ban since the Food Crisis 2008, has spurred not only a general increase in the retail prices of rice across regions in Indonesia but also price divergence on two dimensions. First, there is an increase in the variation of retail prices across regions. Second, there are widening wedges between retail prices and farm-gate prices.

The trade protection to rice farmers is expected to provide earning supports and incentivize domestic rice production. However, I find that rice-producing districts do not enjoy higher purchasing power compared to other districts. I also find no evidence of the growth of the rice sector, either in the form of extensification or intensification. This paper aims to shed light on the potential reason for this result by exploring trends and potential factors that affect retail and farm-gate prices. To the best of my knowledge, this paper is the first in studying regional variation and trends in farm-gate prices, including how they differ with the variation and trend of retail prices of rice during this import-ban era in Indonesia.

I draw four facts from the exploration of the price divergence. First, the relative ranking in prices persists during the import ban. Second, relative ranking in prices is inversely related to crop suitability, in which provinces with high relative ranking in prices have a lower potential yield in growing rice. Third, retail prices and farm-gate prices have different behavior in relation to the lack of import competition during the import ban. Retail prices increase more in provinces with higher import pass-through elasticity, but not for farm-gate prices. Fourth, there is no indication of worsening transportation and communication infrastructure that may increase trade costs. Yet, information frictions may matter more on the upstream side of the rice value chain.

In light of these four facts, I propose two main potential features that need to be taken into account. First, there seems to be less role of search costs in the retail market in the face of strong incentives to arbitrage. In addition, information frictions may matter more to farmers. It is worth exploring the mechanism on how information friction affects farm-gate price determination, for example through better outside options, or increase in market power, or direct arbitrage. Second, since trade costs and search costs may not be the main key determinants in the lack of arbitrage, researchers should consider analyzing whether there is any strategic behavior present in the trading of rice as well as imperfect competition and increasing trade frictions along the rice value chain. Such strategic behavior may emerge especially due to the lack of import competition. In such a case, both the incomplete pass-through of the retail price to farm-gate price and lack of arbitrage can be the expected outcomes.

Understanding the incomplete pass-through of retail prices to farm-gate prices and the lack of arbitrage is important in any effort to evaluate the import ban. Given the insignificance of the impact of the import ban in providing higher purchasing power nor in expanding the rice sector, a rigorous study of the policy is necessary to avoid further misallocation that may occur due to the trade protection. To perform the policy evaluation, I propose the prioritization of collecting regional farm-gate prices and prices of grains along the rice value chain and intra-national rice trade data.

Appendix 2

Tables

Table 14: Data availability for farm-gate prices of rice

Year	Availability	Year	Availability
2003	✓	2011	✓
2004		2012	✓
2005		2013	
2006	✓	2014	
2007	✓	2015	✓
2008	✓	2016	✓
2009		2017	✓
2010		2018	✓

Notes: The check mark (✓) sign indicates data availability. Data is obtained from *Statistik Harga Produsen Gabah* published by BPS.

Table 15: Crop extensification: Rice

	Dep. var: harvested area		
	(1)	(2)	(3)
Bottom tercile, 2011	0.00268	0.00381	0.00380
	(0.087)	(0.087)	(0.087)
Second tercile, 2011	0.0511	0.0511	0.0511
	(0.053)	(0.053)	(0.053)
(ln) Potential yield: rice		1.422***	1.447***
		(0.242)	(0.248)
Price shocks: palm			0.730
			(0.764)
N	565	565	565
R2	0.487	0.528	0.529

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable is (ln) harvested area for rice. The regressions are run on panel of districts with two periods. The two periods are year 2001 and 2011. The coefficients for each tercile are relative to the top tercile in exposure to rice price shocks. Year FEs are included in all specifications. I use robust standard error.

Table 16: Shapley-Shorrocks decomposition for retail prices

Components	Contribution to variation in log real retail prices (%)		
	all periods	before the import ban	import-ban era
Monthly rainfall	1.27	1.46	0.89
Province FEs	19.21	29.65	24.15
Time FEs	79.52	68.88	74.96
Period	1993-2014	1993-2003	2004-2014

Notes: Time FEs are month-year fixed effects.

Table 17: Shapley-Shorrocks decomposition for farm-gate prices

Components	Contribution to variation in log real farm-gate prices (%)	
	all periods	import-ban era
Monthly rainfall	0.47	0.15
Province FEs	25.94	38.76
Time FEs	73.59	61.09
Period	2003-2012 with gaps	2005-2012 with gaps

Notes: Time FEs are month-year fixed effects.

Table 18: Price beheviour before and after the ban: retail prices

	(1)	(2)	(3)
Post 2004		1.220***	0.221***
		(0.259)	(0.060)
Distance to THA/VNM	0.031***	0.230***	0.039***
	(0.005)	(0.021)	(0.008)
Distance to THA/VNM x post 2004		-0.068**	-0.013**
		(0.032)	(0.006)
Retail price, t-1	0.842***		0.839***
	(0.028)		(0.029)
Lag price	yes	no	yes
Period	1993-2014	1993-2014	1993-2014
R-squared	0.968	0.892	0.968
N	6851	6881	6851

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Distance to THA/VNM refers to the simple average of the distance between the province capital cities with ports in Bangkok, Thailand and Ho Chi Minh City, Vietnam. All specifications include province FEs, time FEs, monthly rainfall for $t, t-1, ..., t-12$. Standard errors are clustered at the province level.

Table 19: Price behavior before and after the ban: farm-gate prices

	(1)	(2)	(3)
Distance to THA/VNM	0.221***	-0.004	0.217***
	(0.039)	(0.035)	(0.038)
Farm-gate price, t-1	0.609***		0.588***
	(0.068)		(0.071)
Lag price	yes	no	yes
Period	2003-2012	2006-2012	2006-2012
R-squared	0.886	0.737	0.837
N	1027	1035	921

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Distance to THA/VNM refers to the simple average of the distance between the province capital cities with ports in Bangkok, Thailand and Ho Chi Minh City, Vietnam. All specifications include province FEs, time FEs, monthly rainfall for $t, t-1, ..., t-12$. Standard errors are clustered at the province level.

Table 20: Correlations of real prices with transportation infrastructure

	Retail prices (1)	Farm-gate prices (2)
(ln) Length of roads	-0.003	-0.005
	(0.008)	(0.059)
Periods	2007-2015	2007-2015, with gaps
R-squared	0.930	0.823
N	2928	770

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: All specifications include average distance to Bangkok and Ho Chi Minh City, monthly rainfall for $t, t-1, ..., t-12$, lag of real prices, province FEs and time FEs. Standard errors are clustered at the province level.

Table 21: Correlation of real prices with communication infrastructure

	Retail prices (1)	(2)	Farm-gate prices (3)	(4)
Mobile-phone use	-0.001		0.008*	
	(0.000)		(0.004)	
Internet use		0.001		0.000
		(0.001)		(0.005)
Period	2011-2014	2011-2014	2011-2012	2011-2012
R-squared	0.934	0.934	0.824	0.822
N	1511	1511	395	395

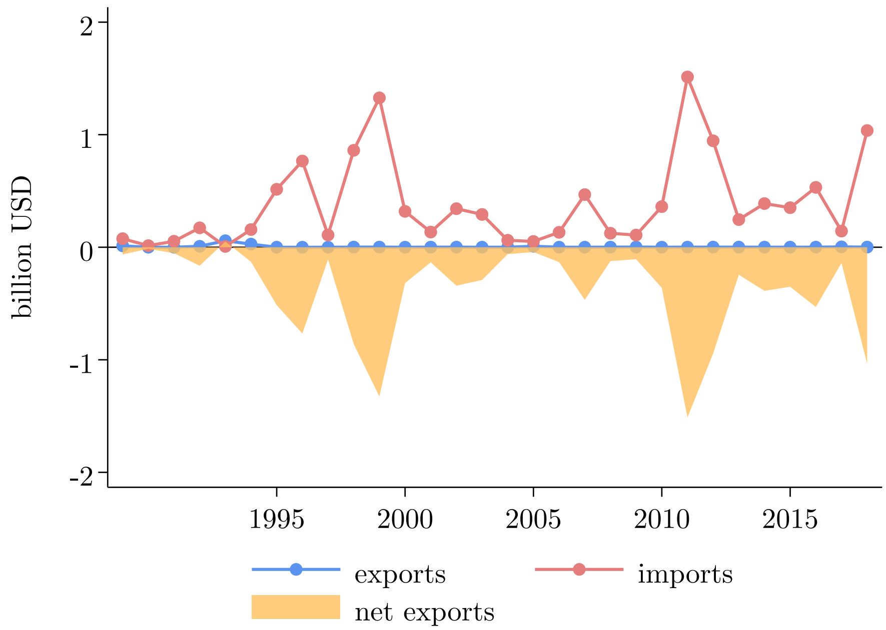
Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Mobile-phone use refers to percentage of households with mobile cellular telephones in each province in year t. Internet use refers to percentage of households who used internet in the past three months in each province in year t. All specifications include average distance to Bangkok and Ho Chi Minh City, monthly rainfall for $t, t-1, ..., t-12$, lag of real prices, province FEs and time FEs. Standard errors are clustered at the province level.

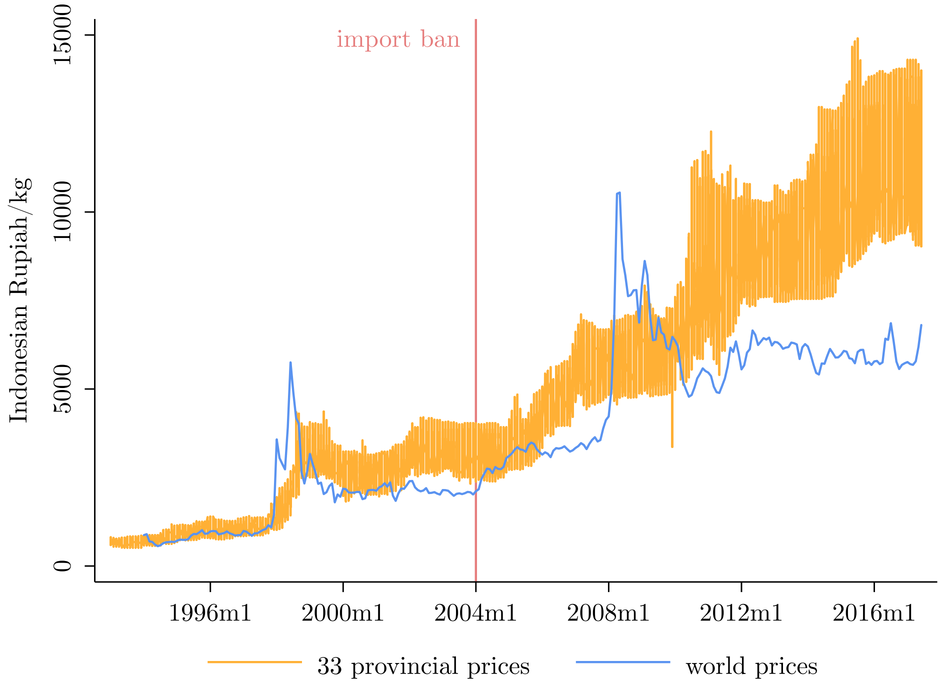
Figures

Figure 28: Indonesia's international trade of rice



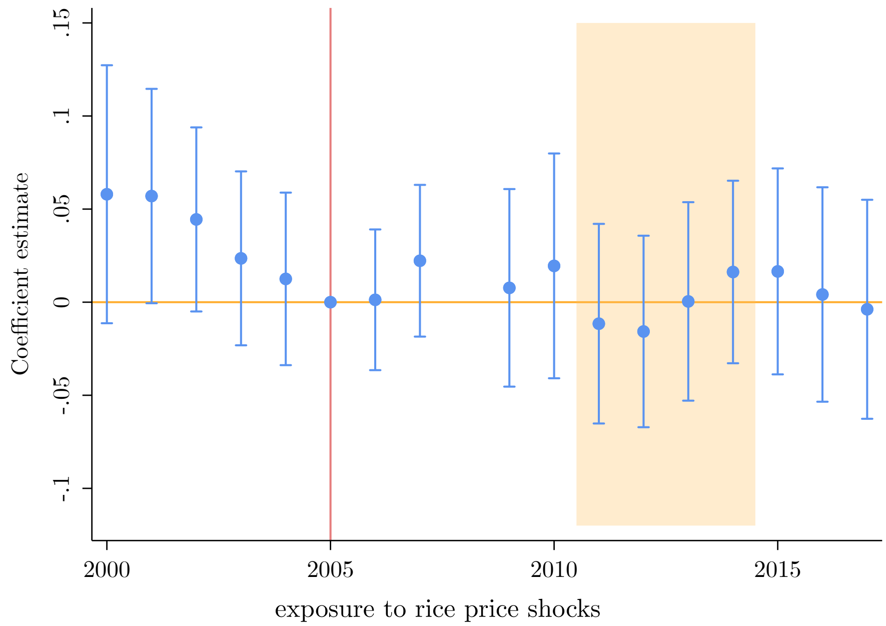
Source: UNCOMTRADE. Author's calculation for net exports.
Notes: Rice refers to HS 1006. Positive net-exports mean that exports exceed imports, while negative net-exports imply imports exceeds exports.

Figure 29: Rice prices (Indonesian rupiah/kg)



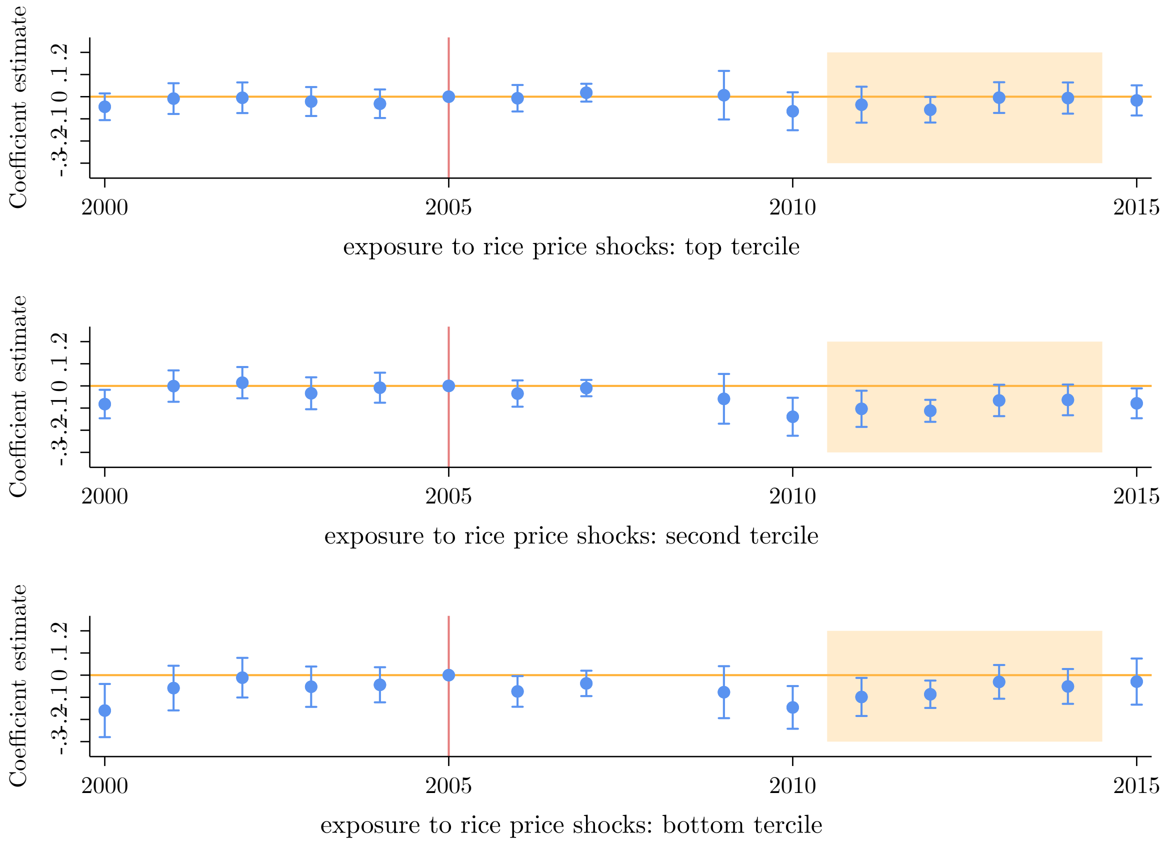
Sources: Domestic prices are 33 provincial rice prices from BPS. World prices are from IMF Commodity Price Series. Author's calculation.
Notes: I follow Dawe (2008) in estimating retail price for imported rice from world price. In particular, I add 20 USD/ton for shipping and a 10% markup from wholesale to retail. I compute the prices in IDR/kg using exchange rate data from FRED.

Figure 30: Impact of rice price shocks on real expenditure per capita



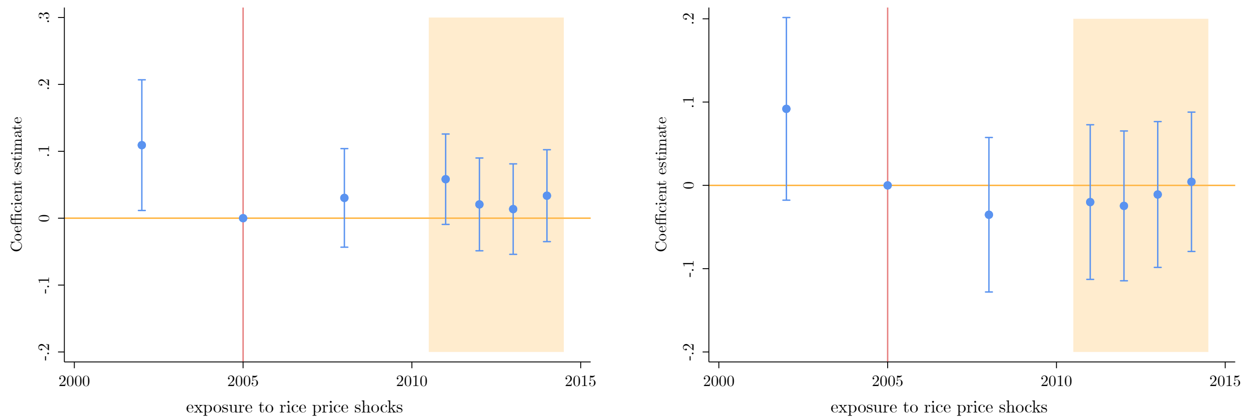
Notes: The dependent variable is the log of (district average) real expenditure per capita. The model includes control variables, districts and year fixed-effects. Regression is run on panel of districts over year with population in 2011 as weights. Standard errors are clustered in district-level. Point estimates are relative to year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

Figure 31: Impact of rice price shocks to real expenditure per capita across terciles



Notes: The dependent variable is (log) real expenditure per capita. The model includes control variables, districts and year fixed-effects. Regression is run on panel of districts over year with population in 2011 as weights. Standard errors are clustered in district-level. Point estimates are relative to year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

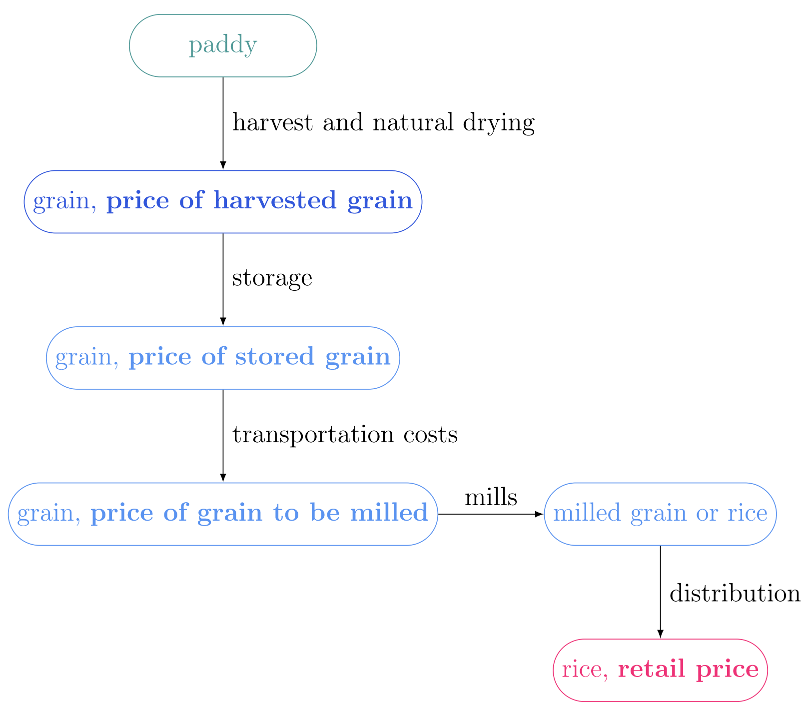
Figure 32: Impact of rice price shocks: Agriculture households and non-agriculture household



(a) agriculture households (b) non-agriculture households

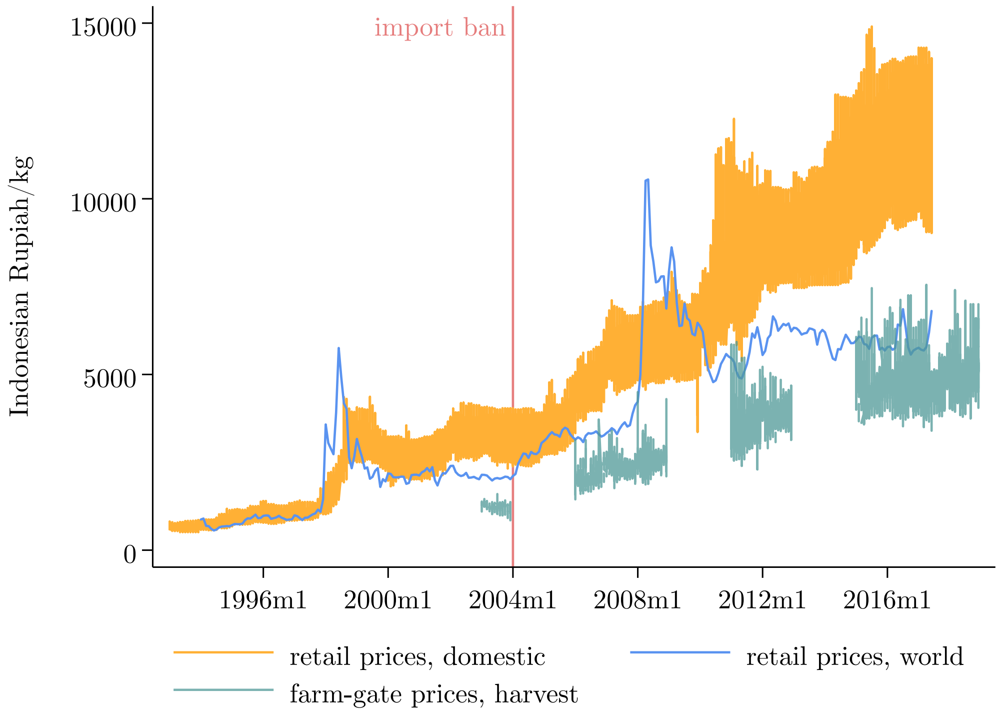
Notes: The dependent variable is the log of (district average) expenditure per capita of agriculture households and non-agriculture households. The model includes control variables, districts and year fixed-effects. Regression is run on a panel of districts over year with population in 2011 as weights. Standard errors are clustered in district-level. Point estimates are relative to year 2005, the omitted category. The 95% confidence intervals for coefficients are shown by the range plots. Shaded area shows post-treatment period.

Figure 33: Rice value chain



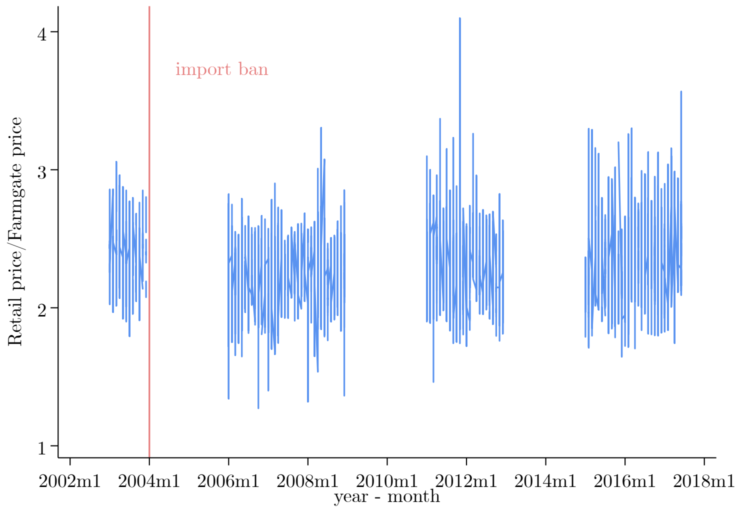
Source: "Konversi Gabah ke Beras Tahun 2018", BPS. Author's illustration.
Notes: I use the prices of harvested grain as farm-gate prices in this study.

Figure 34: Trend of provincial retail and farm-gate prices for rice



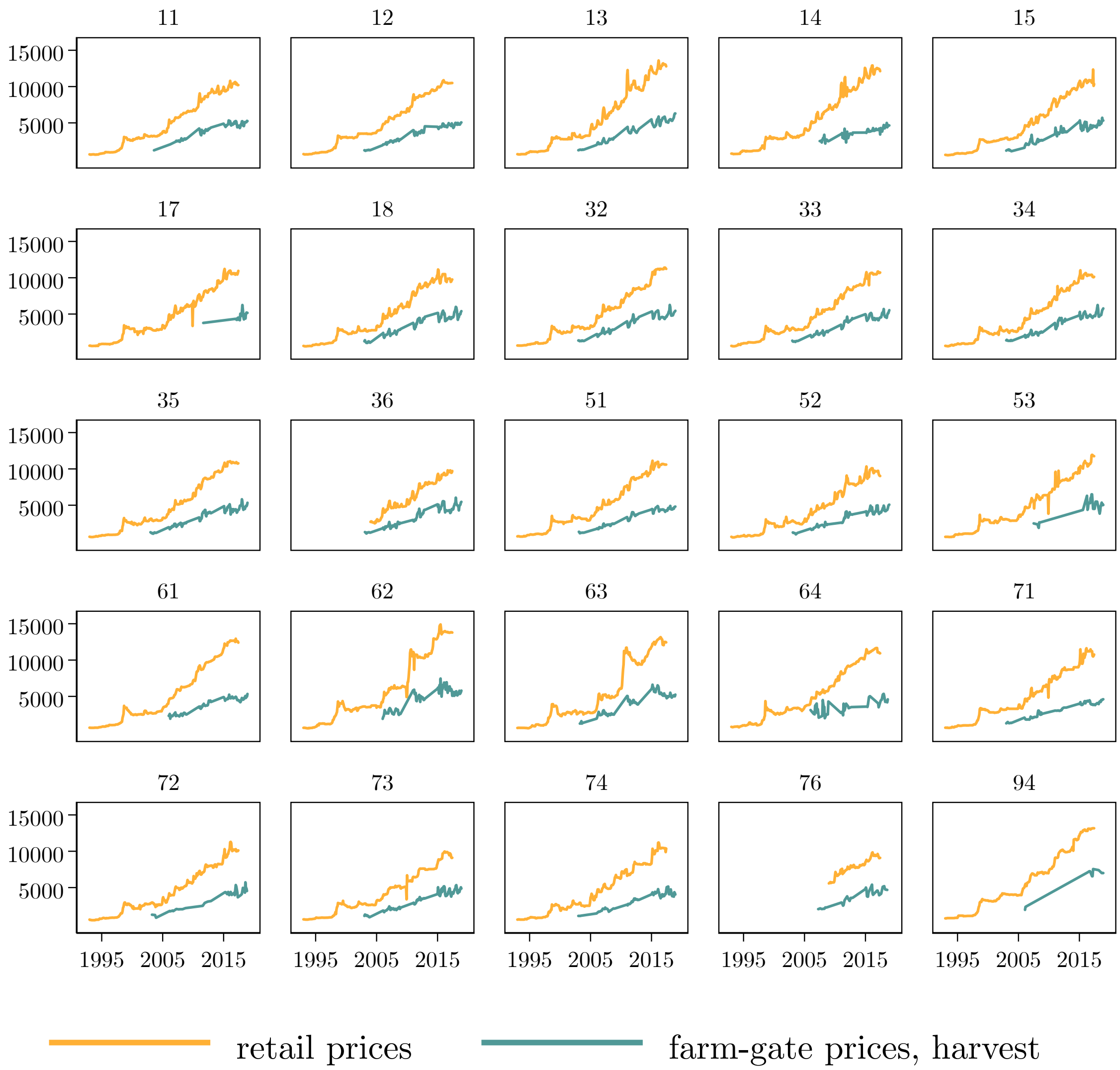
Sources: Domestic retail and farm-gate prices are provincial-level prices from BPS. World prices are from IMF Commodity Price Series. Author's calculation.
Notes: I follow Dawe (2008) in estimating retail price for imported rice from world price. In particular, I add 20 USD/ton for shipping and a 10% markup from wholesale to retail. I compute the prices in IDR/kg using exchange rate data from FRED.

Figure 35: Variation in wedges of rice prices over time



Sources: Retail and farm-gate prices are from BPS.
Notes: Wedges between retail and farm-gate prices are the ratio of retail price to farm-gate price. The vertical line for each year refers to the range of provincial-level wedges of rice prices. Wedges are not always available for all provinces for every month-year period.

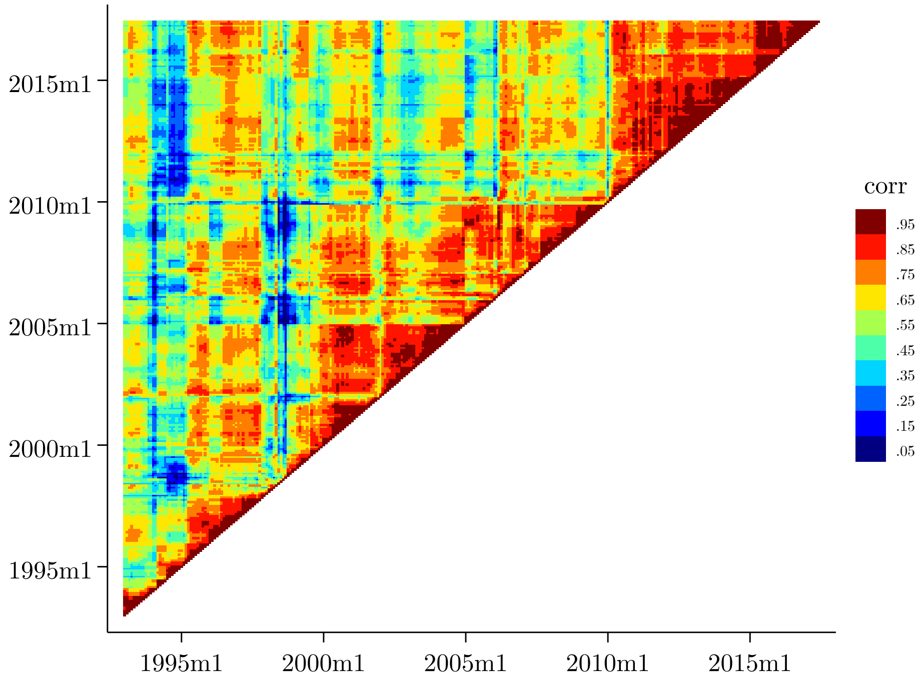
Figure 36: Retail and farm-gate prices of rice by province



Selected provinces

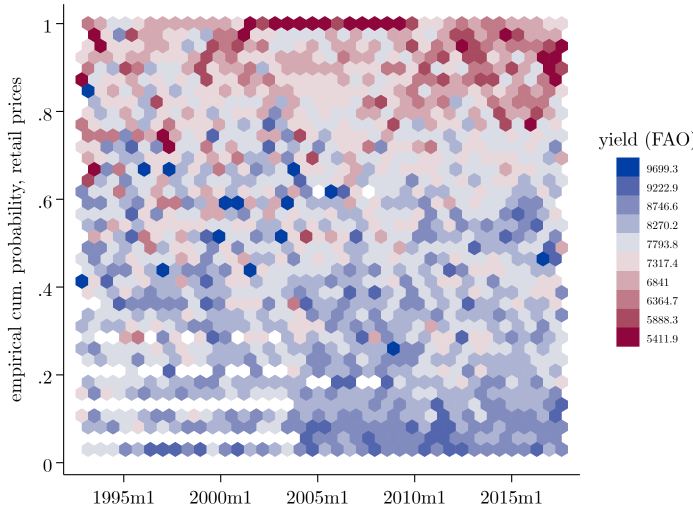
Sources: BPS.
Notes: Provinces are selected based on completeness of retail and farm-gate prices data.

Figure 37: Correlation of relative (retail) prices over time



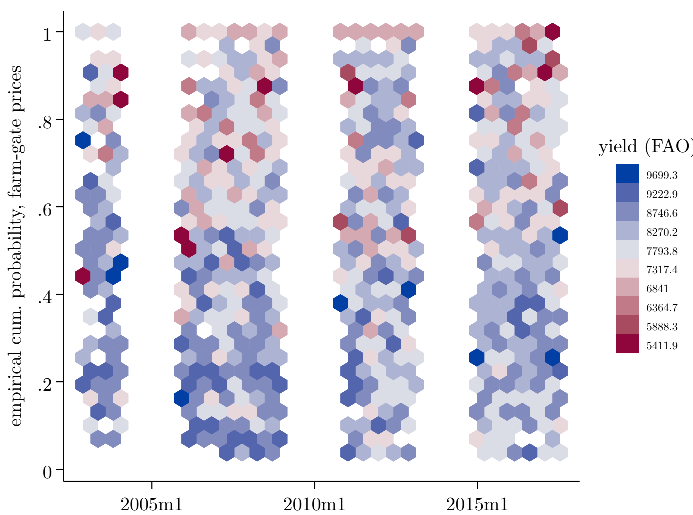
Sources: BPS. Author's calculation.
Notes: I follow Allen (2014) in depicting correlation of relative prices over time. The unit of observation on the figure is the estimated correlation of relative ranking between a month-year in the horizontal axis and a month-year in the vertical axis. The relative ranking is defined as the empirical cumulative distribution function of the retail price for rice in a specific province. It shows the fraction of prices in other provinces below this particular province in a given month-year. Lighter (or hotter) colors indicate high correlations, while darker (or colder) colors indicate lower correlation. Negative correlations are indicated with the darkest color. The sample includes province-level monthly retail prices in January 1993 to December 2017.

Figure 38: Relative ranking in retail prices and crop suitability



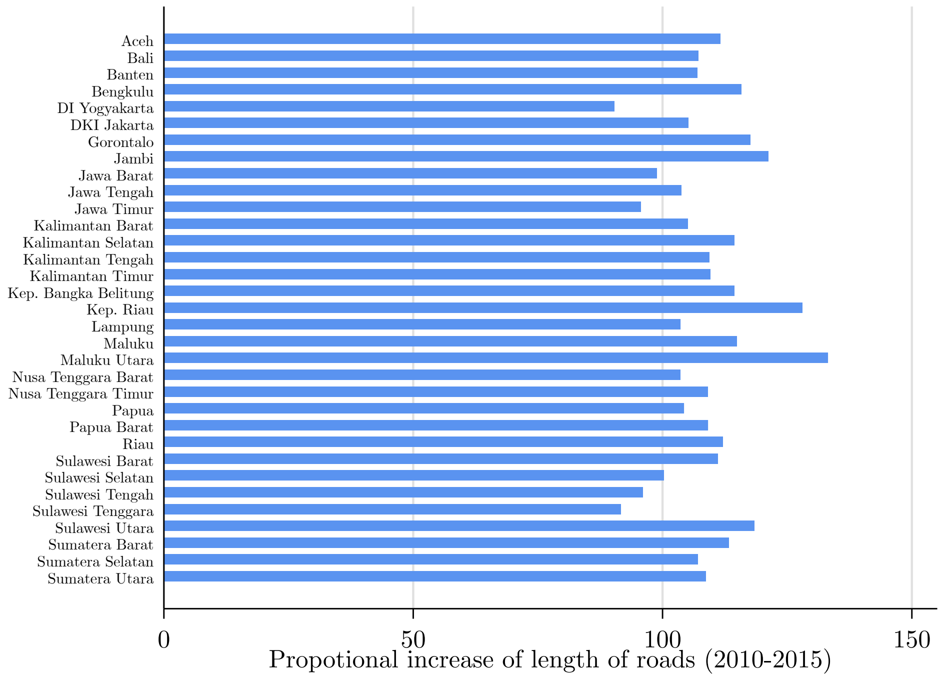
Sources: Retail prices from BPS, crop suitability from FAO GAEZ. Author's calculation.
Notes: The unit of observation is a province-month-year. The empirical cummulative probability for a particular province and month-year is the fraction of provinces with lower price than that province at the month-year. Provinces with higher potential yield in rice are in blue. Provinces with lower potential yield in rice are in red.

Figure 39: Relative ranking in farm-gate prices and crop suitability



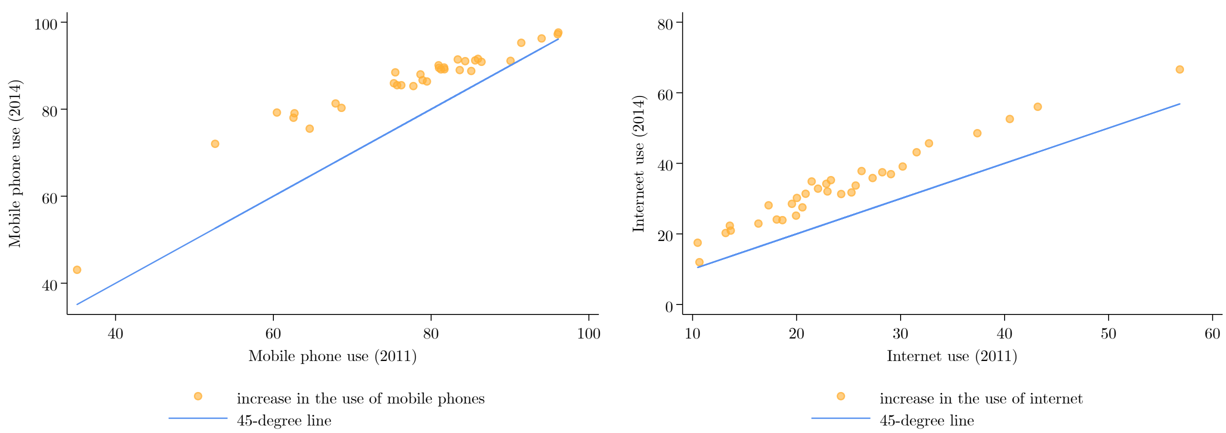
Sources: Farm-gate prices from BPS, crop suitability from FAO GAEZ. Author's calculation.
Notes: The unit of observation is a province-month-year. The empirical cummulative probability for a particular province and month-year is the fraction of provinces with lower price than that province at the month-year. Provinces with higher potential yield in rice are in blue. Provinces with lower potential yield in rice are in red.

Figure 40: Development of transportation infrastructure



Sources: BPS. Author's calculation.

Figure 41: Development of the use of communication infrastructure



Sources: BPS. Author's calculation.
Notes: Each unit is a province. The 45-degree line represents no increase in mobile-phone use or internet use.

Chapter 3

New-consumer margin at work: Exposure to television ads as driver of smoking prevalence

3.1 Introduction

> Tobacco is not just a threat to health, it is also a threat to sustainable human development. (The Lancet, 2015)

Killing more than 8 million people every year, the World Health Organization states that the tobacco epidemic is one of the biggest public health threats that the world ever faced (WHO, 2020). Despite a general decline in the global smoking prevalence, the epicentrum of the epidemic now occurs in developing countries, many of which experience rising smoking prevalence. In fact, low- and middle-income countries account for more than 80% of 1.3 billion world's tobacco consumers.[44] Tobacco consumption is not only costly due to the burden of diseases but also due to the impact of reverting expenditure from more productive uses. Given the rising rate of smoking in developing countries and the cost it bears, it is important to understand what determines the new generations of smokers.

This paper investigates how an improvement in marketing technology used to advertise tobacco products affects smoking pevalence. In particular, this paper finds that higher relative local exposure of televisions (TV), which proliferates the broadcasts of tobacco advertisements, increases smoking participation of young adults. This research contributes to the literature and inform policy makers as it is the first study with nationally-representative

[44] Ibid.

data that focuses on the impact of marketing to smoking participation in developing countries setting, where smoking prevalence has been on the rise.

In order to answer the research question, I derive the theoretical prediction of the impact of improvement in marketing technology to market shares based on the theory of marketing in international trade as in Arkolakis (2010). The model introduces a new margin in gains from trade, the new-consumer margin, which represents additional consumers as trade, including marketing costs, declines. I collect three empirical facts that may affect the new-consumer margin in the context of the Indonesian economy in 1990 to 2010. First, there is no substantial change in the tobacco industry's average productivity. Second, as private TV stations started to broadcast in 1993, there has been an improvement in marketing technology as such TV stations advertised tobacco products. Third, real prices of cigarettes, the most common tobacco products consumed in Indonesia, have been relatively stable during the period of study. Hence, the Indonesian economy in this period is an excellent context in which to study the impact of an increase in advertising exposure to smoking prevalence.

Then, I empirically test the theoretical prediction that improvement in marketing technology generates more consumers. I focus on understanding the impact of marketing technology on young adults aged 17 to 23 years old, as preferences, including smoking habits, are formed during this life phase (Chaloupka et al., 1997). I exploit the spatial and time variation of relative local TV exposure in 2000 and 2007. Using this measure of TV exposure, I perform a difference-in-difference method to study the evidence of new-consumer margin by finding the impact of TV exposure to smoking participation of young adults. In addition, I explore whether smoking behavior has economic consequences. Since I use the Indonesian Family Life Survey (IFLS) data, a longitudinal household survey, I can observe the respondents' economic outcomes seven or fourteen years after being young adults in 2000 or 2007. In order to overcome the endogeneity issue, I instrument current smoking participation with smoking participation during young adulthood to study the impact of smoking to two economic outcomes: college-degree attainment and working status.

There are two main findings. First, I empirically confirm the theoretical prediction that improvement in marketing technology creates new consumers. This paper finds the evidence of the new-consumer margin, in which young male adults living in subdistricts with higher relative TV exposure have a higher chance of smoking. Furthermore, heterogeneity across age groups matters. The impact is significant for younger male adults, especially those of 17 to 19 years of age. An increase of local TV exposure by one standard deviation increases smoking participation by 4%, 5%, and 6%, respectively, for young male adults of 17, 18, and 19 years old. The evidence on new-consumer margin is robust using a different measure of TV exposure, controlling for changes in price of cigarettes, as well as if we include young adults who are also household heads in the sample.

Second, I observe evidence of the long-run economic consequences of smoking. Using the instrument variable approach, I find that male adults who smoke have less probability of attaining a college degree. This result may reflect the role of tobacco consumption in diverting away resources from investment in human capital such as education. Meanwhile, young male adults in the year 2000 also have less chance of having a job in 2014 if they smoke. However, I do not find a significant impact for young male adults in the year 2007. Such result may reflect the mechanism that smoking is perceived well in the society, it may facilitate casual or informal networks. However, I do not find any significant positive impact of smoking in the chance of getting a job.

This paper contributes to several topics in globalization and development literature. First, it contributes to the literature on the impact of introduction and proliferation of electronic media, an inherent aspect of globalization, to human and social capital outcomes. The paper fills in the gap by studying how exposure to advertising through TV increases smoking participation within a developing-country context, where smoking prevalence is rising. It is closest to the study on the impact of the introduction of TV to smoking prevalence in the US by Thomas (2019). However, instead of comparing smoking prevalence before and after the introduction of television, I compare the relative intensity of TV exposure, which is a relevant context in today's society. I also follow Olken (2009), who studies the proliferation of private TV stations in Indonesia and finds that more time spent in consuming electronic media is associated with less social capital outcomes, such as lower participation in social organization and lower self-reported trust. Meanwhile, Kearney and Levine (2015) find that media may have positive influence on social outcomes by showing that the "16 and Pregnant" TV show reduced teen births as it increased interest in contraceptive use and abortion.

Second, this paper contributes to a wide and active literature on smoking behavior. Chaloupka and Warner (1999) provided a comprehensive survey of literature on the economics of smoking, while Wellman et al. (2006) surveyed recent tobacco-related studies in the public health field. From the context of Indonesia, Setyonaluri et al. (2008) presented comprehensive descriptions and a survey of literature. Many empirical works in this stream of literature focuses in analyzing the impact or changes in prices and taxes as tobacco-control policies.[45] Hence, they focus more on smoking cessation and intensive margin of tobacco consumption. I contribute to this literature by studying an important margin in smoking prevalence, i.e., smoking participation among young adults, that stem from advertising exposure. As Warner et al. (1992) emphasized, despite advertisement is not the sole determinant that young adults start smoking, it is the most policy tractable. Hence, understanding the impact of advertising contributes directly to providing evidence-based tobacco-control policies.

Lastly, this paper also relates to the literature on the role of advertising in international trade and firm dynamics. In particular, I find evidence of the new-consumer margin, as introduced by Arkolakis (2010), for a particular industry within a market. Using smoking participation as indication of new consumers, I show that improvement in marketing technology enlarges the consumer base of tobacco products in Indonesia. Recent studies in understanding how firms grow have emphasized the substantial roles of advertising. Using detailed consumption data and TV advertising data, Argente et al. (2021), for example,

[45] See for example Becker et al. (1994) and Cotti et al. (2016) using US data and Ross and Chaloupka's (2006) survey for developing countries.

showed that the growth of firms in market share within a market is driven more by advertising, rather than markups. Meanwhile, Cavenaile and Roldan-Blanco (2021) incorporate advertising decision into endogeneous growth with research and development (R&D) and show that advertising and R&D are substitutes. Importantly, they find that bigger firms rely more on advertising than on R&D.

The rest of the paper is structured as follows. In Section 2, I describe the recent development in tobacco consumption, the tobacco industry, as well as tobacco-control policies in the world and in Indonesia. In Section 3, I lay out the basics of the marketing theory in international trade based on Arkolakis (2010), and derive the theoretical predictions of the impact of improvement in marketing technology to market shares. Based on the theoretical framework, I document the trend of three factors that may affect the number of tobacco consumers in Indonesia. Then, I empirically test the theoretical prediction of the existence of the new-consumer margin. I explain the data as well as the empirical strategy in Section 4. In Section 5, I present and discuss the evidence of the new-consumer margin as well as explore the long-run economic impacts of smoking. In Section 6, I provide the conclusions of the paper and propose some implications from the findings.

3.2 The economics of smoking

In this section, I provide some background in terms of tobacco consumption, the tobacco industry, and tobacco-control policies in the world in general and in Indonesia in particular.

3.2.1 Tobacco consumption

Globally, we have witnessed a general decline of smoking prevalence over time. Figure 42 shows adult male smoking prevalence by countries in the years 2000, 2005, 2010, and 2015. Red colors depict higher smoking prevalences while yellow colors depict lower rates. We can see that in the span of 15 years, many countries have turned from red to yellow. The decreasing trend in smoking prevalence is especially starker in developed economies.

Despite such an encouraging development, there is a wide variety in the achievement of or failure to reduce smoking prevalence. Figure 43 shows that many developing countries, especially those in Africa and Asia, either have lower decline rates or have experienced increases in smoking prevalence. Congo experienced the largest growth in smoking rates with 37.2 percentage point increase between the years 2000 and 2015. Meanwhile, in the same period, smoking prevalence increased by 14.6 percentage points in Indonesia. The country jumped up to the second highest in smoking prevalence in 2015, with a 75.2 percent smoking prevalence rate for adult males, from the sixteenth place in 2000.

In conjuction with the high smoking prevalence in Indonesia, tobacco products have been documented as one of the main commodities in Indonesian households consumption basket. Indeed, tobacco products contribute the third biggest share in households consumption basket after rice and prepared foods. Table 22 also shows that in both rural and urban households, expenditure shares on tobacco products have been around 4-6% in urban area and 7-8% in rural areas throughout 2000 to 2015. In addition, households spend on average more on tobacco products compared to education or health services. Spending on tobacco products constitutes at least twice of household's average spending on health services.

The real expenditures on tobacco products per capita have increased as well. Constructed from the Indonesia Family Life Survey (IFLS), a longitudinal panel of households data, Figure 45 shows that the distribution of per capita consumption on tobacco products has shifted to the right from 1993 to 2014.

There is substantial variation in smoking prevalence across regions in Indonesia. Figure 44 shows the smoking prevalence in populations of 15 years or older, retrieved from the Indonesia's Social and Economic Household Survey (*Susenas*) in 2016 across districts and provinces. Comparing districts, the median is 30%, while the 10th percentile and 90th percentile are 22.5% and 35%, respectively.

Table 23 compares the increases in smoking prevalence across age groups and sex in 1995, 2001, and 2004. Two facts stand out: first, smoking participation is more common among males. Second, the younger age male groups experienced the highest percentage change increase with an increase of 139% and 49% for the age groups 15 to 19 years old and 20 to 24, respectively.

In addition, 97% of tobacco consumption take the form of cigarettes in Indonesia. Clove cigarettes or *kreteks* are more popular among tobacco users in Indonesia, compared to white cigarettes. As 60 to 70% of the ingredients in clove cigarettes are tobacco, they have the same health risks as other types of tobacco products (Setyonaluri et al., 2008).

3.2.2 Tobacco industry

The global tobacco industry can be categorized as oligopolistic, with several key players in the industry, with the top five companies accounting for more than 80% of the world cigarette market.[46] It is widely studied that these firms grew by opening foreign affiliates or acquiring local tobacco manufacturing firms to penetrate markets. These firms rely on expanding their consumer base to especially to less-mature markets in Africa, Asia, and the Middle East (Gilmore et al., 2015).[47] Lee et al. (2012) survey the literature that documents and analyzes how the trans-national tobacco companies penetrate markets in the low- and middle-income economies. These firms actively build presence through influencing tobacco-control policies as well as promoting tobacco use by foreign direct investment and customized marketing and advertisement of tobacco brands and products to each market environment.

The tobacco manufacturing industry is not a new industry in Indonesia; it established its footing in the early 20th century, even before the country's independence in 1945. The tobbacco industry has many small firms with a few large fims. Figure 46 plots those firms' ranks in revenue and log revenue in 1994 and 2004. We can see that the characteristics persists over time. Indeed, just like the structure in the global market, the tobacco industry

[46] See Table 24 for market shares of the top tobacco manufacturing firms.

[47] Other studies which document such globalisation strategies by the main trans-national tobacco companies, for example, include Lee and Eckhardt (2017) and Stuckler et al. (2012).

in Indonesia is also an oligopoly, with the three biggest firms accounting for more than 70% of the market share (Setyonaluri et al., 2008).

There are a few firms with some foreign ownership. Table 25 shows the evolution of the number of foreign and domestic firms over time, which are part of the medium and large manufacturing survey. In our period of interest, the 1990s and 2000s, there are hundreds of domestic firms but less than a dozen firms with any foreign ownership. Comparing firms by status of foreign ownership, Figure 47 shows that the industry production has been dominated by domestic firms.

The tobacco industry is also concentrated in two provinces: Central Java and East Java. These two provinces account for 90% of all tobacco manufacturers.[48] It seems that these tobacco manufactureres cluster to get access to their main inputs as these provinces are also the main producers of tobacco leaves. The top seven districts in tobacco farming are located in the Central and East Java provinces. They account for 84% of national tobacco leaves production (Sahadewo et al., 2021).

In terms of international trade, most of tobacco manufacturers, including the foreign-owned ones, sell domestically. Only around 2 to 4% report to sell products overseas. Meanwhile, they also source their raw materials mostly from domestic suppliers. Between 1990 and 2010, on average 6% of firms reported they have imported materials, with an average of 16% of their materials are imported. Specifically for cigarettes, Indonesia's imports fluctuate but range between 0.5% to 6% relative to the domestic cigarette productions (Setyonaluri et al., 2008).

Lastly, another characteristic that stands out is that the (ln) output per labor, as a raw proxy for productivity, positively correlated with the market size of the firm as indicated by (ln) revenue. This pattern is robust over time. For instance, Figure 48 shows this positive correlation in 1994 and 2004.

[48] Calculated from Manufacturing Survey data.

3.2.3 Tobacco-control policies

The global decline in smoking prevalence has been driven by a stronger commitment to implement tobacco control policies. In 2003, the World Health Assembly adopted the WHO Framework Convention on Tobacco Control (WHO FCTC). The treaty is the first international treaty under the auspices of the WHO. The WHO FCTC came into force in 2005. There are 168 countries which signed the FCTC (WHO, 2021). Countries ratifying the treaty commit to conduct measures to control tobacco use, including by reducing demand for tobacco, regulating marketing activities, and providing alternatives to those growing and producing tobacco (WHO, 2015).

Indonesia, despite being a member of the WHO, has not ratified the FCTC. Tobacco-control policies and regulation are governed by the central government although there are some local governments which impose stricter tobacco-control policies. The numbers of local governments with stronger regulations unfortunately are still very limited.[49]

Setyonaluri et al. (2008) compiled and documented tax regimes imposed on tobacco products and argued that the complexity of the tiered tax system based on production volumes, that aims to protect relatively smaller tobacco manufacturers, contributes to the industry's characteristics of having many small firms. They also showed that the main tax rate changes were imposed in 2008. In addition, they argued that in comparison to other low-income countries and regional averages, Indonesia's cigarette taxes and prices are relatively low.

In terms of age limit, Indonesia started to have a minimum age for tobacco products procurement in 2012. Since then, one has to be 18 years or older to be able to purchase tobacco products. There were no age limits before 2012.

Furthermore, there are no complete smoking bans on tobacco advertisements in the national-level regulation. Regulations for advertising on electronic media began 2000. Specif-

[49]The main regulations are Goverment Regulation No. 81 Year 1999, Government Regulation No. 38 Year 2000, Government Regulation No. 19 Year 2003, and Government Regulation No. 109 Year 2012.

ically, tobacco advertising can only be aired on television between 9:30 pm to 5:00 am local time. The regulations also impose obligations on tobacco packaging and labelling. Pictorial health warnings have only beeen required since 2012.[50]

3.3 Theoretical framework and empirical facts

In order to answer the research question of how improvement in marketing technology to advertise tobacco products affects smoking prevalence, I apply the theory of marketing cost in international trade as developed by Arkolakis (2010). I use this framework especially in understanding how exposure to advertising, both directly and indirectly, affects the decision to start smoking. In this framework, such margin is called the new-consumer margin. This margin is distinct from the other two more common margins in gains from trade, the intensive margin and the extensive margin.

By focusing on the new-consumer margin, I acknowledge that, especially for an addictive substance like tobacco, the utility function may need to take into account factors such as past consumption and/or a high or varying discount rate in explaining the amount of tobacco consumpotion. Hence, I do not aim to focus on understanding the intensive margin due to improvement in advertising as the main focus. Chaloupka and Warner (1999) provide an excellent summary on various utility functions which explain the addiction aspects of smoking consumption. They categorize economic models of addiction into three groups: imperfectly rational models of addictive behavior such as Strotz (1955) and Thaler and Shefrin (1981), models of myopic addictive behavior such as Farrell (1952), and models of rational addictive behavior such as Becker and Murphy (1988) and Becker et al. (1991). In addition, since I focus on one particular market, I also do not focus on whether the improvement in marketing technology creates new producers and importers, i.e., the extensive margin.

[50]For more further summarized details on tobacco-control policies, please refer to for Tobacco Free Kids.

3.3.1 Theory of marketing cost in international trade à la Arkolakis (2010)

Arkolakis (2010) develops a theory of marketing cost in international trade that generalizes the international trade model with heterogenous firms as in Melitz (2003) and Chaney (2008).[51] In this environment, heterogenous firms operate with constant-return-to-scale (CRS) technology with productivity ϕ. These firms sell their products under monopolistic competition.

The main difference in Arkolakis's (2010) setup is that firms incur marketing costs to reach individual consumers in each market. Let us define S as the number of advertisements (ads) sent by a firm, L as the numbber of consumers, and $n(S)$ refers to the probability that a particular consumer sees the ad at least once after S ads have been sent.

There are three assumptions to capture the nature of the marketing technology. First, the number of consumers who see each ad is given by $L^{1-\alpha}, \alpha \in [0, 1]$. The parameter α is the main parameter of interest in this paper. When α equals to one, each add is read by one consumer. This case mimics the use of advertising with flyers. Meanwhile, when α is equal to zero, then one ad can reach a given share of consumers in a market. An example of such marketing technology is television ads. I refer to improvement in marketing technology as a decrease in α.

The second assumption captures the decreasing return or increasing marginal cost of marketing. In particular, Arkolakis (2010) assumes that the probability that a new ad is seen by a consumer for the first time is $[1 - n(S)]^{\beta}, \beta \in [0, +\infty)$. This assumption is relevant for the case of cigarette consumption. Brown (1978) and Thomas (1989), for example, show evidences tha thet cigarette industry faces diminishing returns in advertising.

Lastly, the third assumption governs the production function in marketing services. Specifically, firms employ a Cobb-Douglas techology that combines labor services in the

[51] I describe only the most relevant aspects of the environment of the model here.

source country i, l_i, and the labor services in the desination country j, l_j as the following: $S = l_j^{\gamma} l_i^{1-\gamma}$, with $0 \leq \gamma \leq 1$.

Meanwhile, a consumer in country j consumes a composite good from combining differentiated commodities using a CES aggregator with elasticity of substitution $\sigma > 1$. . The consumer receives income, y_j, from her labor income, w_j, and profits earned, π_j. Hence, the demand for each variety as a function of productivity, ϕ, is the following:

$$c_{ij}(\phi) = \frac{p_{ij}(\phi)^{-\sigma}}{P_j^{1-\sigma}} y_j, \tag{33}$$

where p_{ij} is the price of that variety and P_j is the price index for all variety consumed by the consumer in market j.

Firms operate using a constant returns to scale technology with productivity ϕ and produce outputs using labor as the only factor of production. In selling to overseas markets, firms face iceberg trade cost, τ_{ij}. The optimal pricing is then a constant markup over marginal cost, or as below:

$$p_{ij}(\phi) = \frac{\sigma}{\sigma - 1} \frac{\tau_{ij} w_i}{\phi}. \tag{34}$$

Firms maximizes profits, which is the difference between revenue with labor cost of production and marketing cost. Hence, provided that the firm enters the market, i.e. $\phi \geq \phi_{ij}^*$, where ϕ_{ij}^* is the entry threshold, the optimal consumers to be reached, n_{ij}, solves the equation below. This equation shows that the marginal revenue (after differencing out labor cost for production) on the left-hand side equals to the marginal cost per consumer on the right-hand side:

$$\frac{y_j}{\sigma} \frac{\left[\tilde{\sigma} \left(\tau_{ij} w_i / \phi\right)\right]^{1-\sigma}}{P_j^{1-\sigma}} = \frac{w_j^{\gamma} w_i^{1-\gamma}}{\psi L_j^{1-\sigma}} \frac{1}{\left(1 - n_{ij}\right)^{\beta}}, \tag{35}$$

where $\tilde{\sigma} = \frac{\sigma}{\sigma - 1}$, is the constant mark-up, and $\frac{1}{\varphi} = \gamma^{\gamma} \left(1 - \gamma\right)^{1-\gamma}$, is the per-unit advertisement costs. Solving equation 35 above for ϕ by setting $n_{ij} = 0$, we can derive the entry threshold ϕ_{ij}^*:

$$\left(\phi_{ij}^*\right)^{\sigma-1} = w_j^{\gamma} w_i^{1-\gamma} L_j^{\alpha-1} / \left[\frac{y_j}{\sigma} \frac{\left(\widetilde{\sigma}\tau_{ij} w_i\right)^{1-\sigma}}{P_j^{1-\sigma}} \psi \right]. \tag{36}$$

Arkolakis (2010) provides three propositions. The first proposition is related to the optimal market penetration decision, which is the focus of this paper. This proposition states that if marketing technology is subject to diminishing returns, i.e. $\beta > 0$, then there exists entry threshold ϕ_{ij}^*, such that:

$$\phi \leq \phi_{ij}^* \Rightarrow n_{ij}(\phi) = 0 \text{ and } \phi_1 > \phi_2 \geq \phi_{ij}^* \Rightarrow n_{ij}(\phi_1) > n_{ij}(\phi_2) \geq 0. \tag{37}$$

While, if marketing technology is not subject to diminishing returns, i.e. $\beta = 0$, then there exists entry threshold ϕ_{ij}^*, such that:

$$\phi \leq \phi_{ij}^* \Rightarrow n_{ij}(\phi) = 0 \text{ and } \phi > \phi_{ij}^* \Rightarrow n_{ij}(\phi) = 1. \tag{38}$$

Thus, the optimal market penetration decision for a firm with productivity ϕ for $\beta \geq 0$ can be expressed as below:

$$n_{ij}(\phi) = \max \left\{ 1 - \left(\frac{\phi_{ij}^*}{\phi} \right)^{(\sigma-1)/\beta}, 0 \right\} \tag{39}$$

3.3.2 Productivity growth

Let us analyze the implication of an increase in a firm's productivity, ϕ. Based on the proposition of market penetration as shown by equation 37 and 38, as well as the optimal market penetration equation that they infer as shown by equation 39, we can draw two results. First, if the firm faces diminishing returns marketing technology, i.e. $\beta > 0$, then the increase in productivity ϕ, increases the firm's optimal market penetration n_{ij}. We can use the first argument in equation 39 to take the derivative of n_{ij} with respect to ϕ and find that the derivative has a positive sign. Equation 37 also shows this relationship, as it says that conditional on entering the market, a more productive firms has higher optimal market share.

3.3.3 Improvement in marketing technology

Conditional on passing the entry threshold, ϕ^*_{ij}, we can predict the impact of the changes in α to the optimal market penetration by taking the derivative of equation 39 and 36 with respect to the marketing technology parameter α. The result is shown below. Since the sign is negative, we can infer that as it gets easier to reach more consumers per ad, or as α declines, then the optimal market share or market penetration, n_{ij}, increases. This is the theoretical prediction that I would like to test empirically in this paper.

$$\frac{dn_{ij}(\phi^*_{ij})}{d\phi^*_{ij}}\frac{d\phi^*_{ij}}{d\alpha} = -\frac{\ln \phi^*_{ij}}{\beta\phi}\left(\phi^*_{ij}\right)^{\frac{\sigma-1}{\beta}} \tag{40}$$

3.3.4 Empirical facts on smoking environment in Indonesia

We can collect two parameters and one variable that may affect optimal market shares. The two parameters are productivity and marketing technology. While an outcome variable that may affect demand is price, here, I document three empirical facts on productivity of tobacco manufacturers, marketing technology, and prices of cigarettes from the Indonesian economy from 1990 to 2010.

Fact 1: Exposure to marketing through television has expanded and varied spatially.

In 1993, Indonesia started to have private-owned television stations. Before 1993, there was only one state-owned television, TVRI. The state-owned television station does not broadcast TV ads, while private-owned TV stations can. Figure 54 compares the average number of TV stations captured in each district in 2003 and 2005.

There are two things we can infer from the figure. First, in both periods, there are substantial spatial variations across subdistricts. Second, the number of private TV stations increased between 2003 and 2005 as there were new TV stations broadcasted. Hence, districts with a given level of exposure in 2003 may still experience some *relative* increase or decrease of exposure due to the addition of these new TV stations.

Fact 2: Industry's average TFP has been relatively stagnant.

I analyze the trend and distribution of total factor productivity (TFP) of firms in the tobacco industry in Indonesia.[52] There are two facts that we can infer from the trend of TFP in the tobacco industry in Indonesia. First, in general, there was no substantial increase of TFP over time in the sample period of 1990 to 2012, except for the last years in the series. Figure 50 shows the simple and weighted average of TFP of the tobacco industry. Both charts show a relatively stagnant level of industry-average productivity.

Second, there are a few firms that grew their TFP substantially in the last years of the sample period. Most of these firms are domestically-owned. Figure 51 shows a panel of estimated TFP with color indication for foreign-ownership status. Comparing domestic firms with firms with any non-zero foreign ownership, we can infer that they have relatively the same level of productiviy.[53]

Several public health studies show that foreign direct investment by trans-national tobacco companies has been the driver of growing market penetration especially in developing countries.[54] In the context of Indonesia from 1990 to 2010, I do not particularly analyze such flows as the drivers in determining smoking prevalence. In addition, despite there having been some major foreign investments, such as the acquisition of Sampoerna by Philip Morris International[55], I do not see any substantial jump or structural break in the industry-average

[52] Please see subsection "Data Appendix: Estimating Total Factor Productivity" in Appendix for details.

[53] There is no guarantee that domestic firms do not get foreign loans for new investments as we cannot observe such non-ownership foreign financial flows because the dataset only record ownership characteristics.

[54] See for example: Bettcher et al. (2003) and WHO et al. (2012).

[55] PMI (2005).

TFP in the data.

Hence, for the period of study in this paper, I do not consider TFP growth as the drivers of tobacco consumption growth.

Fact 3: Real prices of cigarettes has been relatively stable.

Another factor that determines tobacco consumption is price of tobacco products, especially cigarettes. WHO, supported by various studies, argues that price increase of tobacco products is the single most effective tobacco control measure WHO et al. (2019). I collect two sources of data to document the trend of prices of cigarettes in Indonesia.

First, the national statistic books provide data on prices of clove and white cigarettes in main markets in Indonesia.[56] Figure 52 shows that both types of cigarettes experienced price increases following the high inflation during the 1997-1998 Asian Financial Crisis. As the economy improved and inflation has been moderated, prices have been relatively stagnant in the 2000s.

Second, I also compute the observed average price of cigarettes from households consumption data in IFLS. Figure 53 presents the trend of this statistics over the five waves of IFLS survey between 1993 to 2014. Echoing the previous finding, we also do not see substantial price increase observed from the households spending on cigarettes.

Both sources of data on prices of cigarettes show that there is no significant price increase over time. As explored earlier, the only substantial tax hike happened in 2008. Supporting the observation that the real prices of cigarettes have been stagnant in Indonesia, Setyonaluri et al. (2008) also found that the real prices of cigarettes have been stable between 1970 to 2005 in Indonesia. Nevertheless, I will include the interaction of province and national price average variable as one of the potential determinants of smoking participation in the robustness analysis.

[56] In earlier years, data was only collected from markets in Jakarta.

3.4 Data and empirical strategy

3.4.1 Data and sample construction

The main datasets used for the outcome of interests, smoking participation, are the Indonesian Family Life Survey (IFLS). IFLS is a longitudinal panel of households constructed from nationally representative household surveys. IFLS represents 83% of Indonesia's population with a more than 90% recontact rate. It has six waves of survey years: 1993, 1997, 2000, 2005, 2010, and 2014. Meanwhile, the main datasets used to extract changes in marketing technology improvement are the Village Census (*Podes*) for the years 2003 and 2005/2006. The Village Census covers the universe of villages, the lowest administrative units in Indonesia, and are conducted triennially.

Individual data recorded in IFLS allow us to capture various determinants of smoking participation that have been studied in the literature. These determinants include not only the individual characteristics but also the parents' characteristics. Since the dataset is a longitudinal panel, we can also study the long-term impact of smoking participation as young adults.

In particular, I will exploit the difference between a set of young adults from two different IFLS survey waves. Since private televisions broadcast stations were introduced in 1993 in Indonesia, it would be interesting to also study smoking behavior pre-television ads, as captured by the first wave of IFLS in 1993. However, this wave only interviewed a selection of respondents in 1993 for its smoking-behavior module. Hence,in terms of smoking behavior responses, the sample from 1993 is not comparable with the sample from the later waves. In addition, given the substantial change in tax on tobacco products in 2008 as well as wider proliferation of other electronic media such as the internet in 2010s, I focus on two waves of the IFLS: 2000 and 2007.

Despite the fact that there was no age limit in purchasing tobacco products in Indonesia before 2012, I focus on understanding the smoking behavior of young adults, i.e., respondents of 17 to 23 years old of age. In the analysis, I include the full sample with both male and female respondents. However, for most of the analysis, I will focus on males as smoking behavior is more acceptable for males in Indonesia. Ng et al. (2007), for example, found that there was a social stigma that discourages females from smoking in Java and Bali, two of the most populous islands in Indonesia.

In addition to using age as one of the selection criteria, I also select respondents who are not heads of their households. The reason for this is because it is important to take into account parents' characteristics in understanding smoking behavior, as is shown im studies such as Witoelar et al. (2005). Since some respondents live with extended families instead of with their own biological parents, I find that the characteristics of the heads of households with whom the respondents live to be the relevant parental characteristics, whether or not the heads of households are or are not the respondents' biological parents. In the robustness analysis, I include all respondents between ages 17 to 23, without selecting on their household member status.

In order to find the causality between exposure to marketing of tobacco products, I follow Olken (2009) in using variation in local reception of television signal strength. Olken shows that local reception is not entirely driven by the endogenous decision of placing TV towers, but is also determined exogenously by geographical features such as terrain and topography. These features affect the strength of reception that can be captured locally. Olken (2009) exploits the timing of the introduction of private TV stations in 1993 as well as the spatial variations in TV signal reception.[57] Since the outcome variable of smoking participation is not completely surveyed in the first wave of IFLS in 1993, I cannot compare the impact of the introduction of television ads by comparing before and after such introduction. Instead, I compare the temporal and regional variation in relative intensity of exposure to televisions.

[57] Olken (2009) showed that, after controlling for disrict fixed effecrs, the number of television channels received in each village was only correlated with three out of 24 geographic, and socio-economic variables. These three variables are: the presence of any social welfare group in 1990, the log number of hamlets, and whether the subdistrict is coastal. Since I use a different dataset than the one used by Olken for the outcome variables, I control for province fixed effects instead of district fixed effects. Olken also explored the impact of the introduction of TVs, while I explore the impact of relative TV exposure.

I believe, such a comparison is more relevant as it may not be feasible to eliminate all aspects of marketing through electronic media such as TV in the contemporary world.

In order to get the measure of exposure to TV ads, I compute the number of TV channels received by each village, as recorded in the Village Census in 2003 and 2006. Then, I take the subdistrict average of the number of TV channels captured across each village.[58] Since there have been improvements in TV reception in general between 2003 and 2005 as well as more private TV broadcasting stations, I compute the standardized value of the average number of TV channels received for each subdistrict. The standardized values have a mean of zero and standard variation of one in each survey wave. This measure is the preferred measure to capture relative intensity of exposure to marketing through television ads. An increase of such measure can be perceived as improvement in marketing technology. Using the theoretical framework previously explained, we can consider an increase in relative intensity of TV exposure as a decrease of α, i.e., one unit of TV ads can reach a bigger fraction of a population.

The main sample includes respondents of aged 17 to 23 years of age from IFLS surveys in 2003 and 2007. Table 27 presents the summary statistics of the outcome and control variables between the selected sample from two survey waves. For each variable, I also present the t-test statistics. Lastly, the table also shows the joint-F test for all variables.

The two groups are comparable in several main variables such as education attainment, working status, share of urban residence, and head of household's real annual income. The main outcome of interest, smoking participation, is significantly higher in 2000 compared to 2007. But the head of households' smoking participation status is statistically higher in 2007. Some other individual and head of households characteristics are also statistically different between the two survey waves. I will include all of these variables as controls in the analysis.

[58] Subdistrict is the next higher administrative level above the village level.

3.4.2 DiD estimates of the impact of TV exposure on smoking participation

In order to study the evidence of the new-consumer margin due to improvement in marketing technology, I run a difference-in-difference (DiD) method as shown by the following empirical specification:

$$Smoke_{icst} = \alpha + \sum_{c} \beta_c TV_{st} \cdot \mathbb{I}_c + \gamma \mathbb{X}_{icst} + \delta_c + \delta_{prov} + \delta_t + \delta_{prov} \times \delta_t + \epsilon_{icdt}. \qquad (41)$$

The outcome variable, $Smoke_{icst}$, is whether individual i, with age cohort c, living in subdistrict s, from survey wave t, smokes or not. This variable is 1 if the person smokes, and 0 otherwise. The main explanatory variable is the relative exposure to ads through televisions, TV_{st}. This variable varies across subdistricts and survey waves. In order to capture the heterogeneity of the impact of exposure through TV across age group, I interact the exposure variable with indicator variable for each age group c, where $c \in \{17, 18, 19, 20, 21, 22, 23\}$. I include a set of individual control variables which consists of individual characteristics and the characteristics of the head of household with whom the individual lives. The specification also includes age or cohort fixed effects, δ_c, province fixed effects, δ_{prov}, survey wave fixed effects, δ_t, and province-survey wave fixed effects, $\delta_{prov} \times \delta_t$. There are two survey waves, with $t \in \{2000, 2007\}$. Hence, the coefficients of interest, β_cs, explore the variation across subdistricts within each age groups.

Which mechanisms represent the impact of TV exposure on smoking participation? First, as Olken (2009) shows, the TV exposure used here correlates with radio reception as well. Hence, we should take the impact as a general effect of broadcast media. In terms of public health mechanism, Warner et al. (1992) provides several direct and indirect mechanisms of how advertisement can affect smoking prevalence. Since the exposure variable is constructed at the community level, in particular, across subdistricts at a given period of time, I consider the impact of TV exposure on smoking participation represents both the direct impact and indirect mechanisms of how advertising affects smoking. These direct mechanisms include reducing motivation to stop smoking, enticing smoking initiation, and encouraging relapse. Meanwhile, the indirect mechanisms include discouraging the provision of full discussion on the hazards of smoking in the media and increasing social acceptance to smoking behavior.

In the specification above, I allow the exposure to ads through televisions to vary across age. Belk et al. (1982) and Moore and Stephens (1975), for example, show that there are certain age ranges, especially during adolescence, in which preferences are formed. For comparison, I also run a simpler specification without differentiating the impact of TV exposure by age groups. In addition to the impact of TV exposure, the age cohort fixed effects, δ_c, would capture the inclination of each age group on average towards smoking.

The set of individual controls consists of two groups of controls: the individual socio-economic variables and the head of household's socio-economic variables. The individual characteristics include whether the individual is still in school, education attainment, working status, marital status, and whether the individual lives in an urban or rural village. In the full sample with both male and female respondents, I also include the gender of the individual. Meanwhile, the socio-economic characteristics of the heads of households include whether they smoke as well as their gender, education attainment, real income, working and marital status.

Furthermore, the specification has province fixed effects, survey wave fixed effects, and province-survey wave fixed effects. The time-invariant province fixed effects will capture all aspects that are province-specific, including inclinations towards smoking behavior in general across provinces. Meanwhile, survey wave fixed effects take care of all time-specific variables that affect all respondents in each survey year, such as general macroeconomic conditions, the growth of industry-average productivity in the tobacco industry, and overall prices of tobacco products. In addition, province-survey year fixed effects will control confounding factors, such as changes in tobacco-control policies imposed by local governments, local economic conditions, and other time-varying province specific variations.

3.4.3 IV Estimates of young adults smoking participation on long-run outcomes

Smoking behavior may have economic consequences. For example, since more income is spent on tobacco consumption and less on investment in nutrition and/or education, one may accumulate less skills. This lower level of skills may then affect one's performance in the labor market. However, it is challenging to investigate this due to the endogeneous relation between current smoking behavior and current labor market performance. I propose to use smoking status in adolescence and young adulthood as an instrument variable (IV) to current smoking behavior to study the impact of smoking to economic outcomes.

This IV approach depends on the variation across individuals in their prolonged smoking prevalence. The dataset that I use here allows me to investigate such prolonged tobacco consumption, as IFLS follows each respondent over time. In particular, I study the several economic outcomes in the most recent IFLS survey wave in 2014 for the respondents selected in the surveys in years 2000 and 2007. For the selected sample in 2000, I explore respondents' economic outcomes 14 years later. While for the selected sample in 2007, I study respondents' economic outcomes after seven years later.

Specifically, the IV approach is performed using the a two-stage linear least square approach. In the first stage, smoking behavior documented in 2014 is regressed on smoking behavior in individuals ages 17 to 23. Then, the second stage estimates the impact of smoking using the instrumented smoking behavior to outcome variables, such as working status and college-degree attainment.

3.5 Results

3.5.1 Evidence of the new-consumer margin

Improvement in marketing technology represented by exposure to television ads expands smoking prevalence by inducing more new smokers. This impact is especially significant for young male of 17 to 19 years of age. The impact of TV exposure on these age groups is significant after controlling for age-specific inclination to smoke as captured by the age fixed effects. Table 28 shows the results for the estimated coefficients of interests from running equation 41, i.e., the sensitivity to smoking participation through TV exposure, in order to investigate the evidence of new-consumer margin due to expansion of exposure to ads on TVs.

First, the impact of TV exposure to smoking participation is not significant for the full sample which includes both male and female respondents. The results for the full sample are shown in columns one to three in Table 28. Such contrast between the full sample and male-only sample is not surprising, as female smoking prevalences across age groups is a lot less compared to the males. As previously mentioned, according to Ng et al. (2007), there is a widespread stigma against females smoking, as smoking represents a manly behavior in Indonesia. Such social acceptance on smoking for males is also present in India as shown by Sen and Basu (2000) as well as in Pakistand and Bangladesh as shown by Bush et al. (2003). Thus, from this point forward, I will focus more on studying the results for the sample set with only male respondents.

Second, the heterogeneity across age groups turns out to be meaningful. The age fixed effects show that the average smoking participation varies across age, even amon young adults as the focus of this study. Figure 55 presents the coefficients and their 95% confidence interval for the age fixed effects for male respondents. These estimated coefficients are quite high to begin with. Among 17-year old males (the age group with the lowest coefficient), there is, on average, a 50% chance of smoking.

Let us explore the results of the main coefficients of interest: the impact of TV exposure to smoking participation. Columns four and five on Table 55 show the estimated coefficients for male respondents. First, column four shows that without taking account the heterogeneity of impact across age group, the impact of TV exposure is not statistically significant. However, living in subdistricts with higher TV exposure increases the chance of smoking participation for the younger group.

In Table 56, column one presents the main result that shows the evidence of new-consumer margin due to improvement in marketing technology. This column shows the marginal effect of TV exposure for each age group, i.e., how much the chance of smoking changes for an increase of one standard deviation of TV exposure. For the age group 17, 18, and 19 years old, an increase in TV exposure significantly increases the chance of smoking participation. In particular, for those of 17 years of age, increasing TV exposure by one standard of deviation increases the chance of smoking by 3.7%. The marginal effect of TV exposure is higher for the age group 18 and 19 years of age, with an increase of 5.6% for chance of smoking due to one standard deviation increase of TV exposure for age group 19 years of age, Meanwhile, the marginal effect of TV exposure is not statistically significant for the older age groups between 20 to 23 years old. Figure 56 illustrates these marginal impacts of TV exposure to smoking participation for each age group across the distribution of TV exposure.

This result is consistent with the impact of introduction to television in the United States to smoking participation as shown by Thomas (2019). Thomas demonstrated that the impact is significant for the youth as well. In addition, TV exposure may not matter much in the smoking participation decision of the older groups in this study as their preference to smoke are formed when they are younger. Holbrook and Schindler (1989), who studied the construction of preference to popular music for example, showed that sensitivity of preference may peak around 24 years of age.

The findings on the evidence of the new-consumer margin here contributes to the understanding of the impact of the different magnitude of exposure through television ads to smoking participation. Previous studies focus on comparing the change in smoking prevalence with and without such marketing channels. Hence, instead of focusing on such a structural break, I focus on how varying relative exposure presents a different impacts. Understanding how the magnitude of exposure matters is important in informing policy makers, especially in regulating tobacco advertisements in the current environment of high accessibility and affordability of media.

Furthermore, I also contribute to the discussion on whether advertisements influence only current smokers or also produce a new generation of smokers. Warner et al. (1992) mentioned that tobacco companies usually argue that the role of advertisement is to encourage switching to their brands or to increase loyalty to their brands. This evidence of the new-consumer margin confirms that advertisements not only affect current smokers but also generate new smokers.

In all specifications, I control for various individual characteristics and head of households' characteristics. The results for these controls are consistent with the literature. Figure 57 illustrates the estimated coefficients for these controls that are factor variable. The blue coefficients refer to the result for the full sample as part of the specification on column two of Table 28, while the yellow coefficients are the results for the male-only sample as part of the specification on column five of Table 28.

In both sets of samples, attending school decreases the chance of smoking for the population of between 17 to 23 years of age. In contrast, working status increases the chance of smoking. Importantly, individuals who live with household heads who smoke, also have a higher chance of smoking. This is consistent with the findings studied by Witoelar et al. (2005) which show that having parents who smoke increases youth's chance of smoking in Indonesia. A study on smoking behavior in youths in Taiwan by Wen et al. (2005) also show the important role of parental smoking behavior. In addition, living in an urban area decreases the chance of smoking, echoing the same result presented by Adioetomo et al. (2005).

Furthermore, Table 30 presents the estimated coefficients for education and income. Especially for our main specification with male-only sample, educational attainment is negatively associated with smoking participation. Likewise, head of households' education attainment is also negatively associated with chances of smoking for the population in 17 to 23 years old of age. In contrast, in the male-only sample, head of household income does not have a statistically significant impact to chances of smoking. The negative association of education and non-significant association of income to smoking participation is consistent with the literature, as shown by Witoelar et al. (2005).

3.5.2 Long-run impacts

The IFLS surveys allow us to observe the dynamic of socio-economic condition over life cycles. This feature allows us to explore the long-run impact of smoking participation when one is young to their condition later in life. I investigate the consequences of smoking behavior to several economic outcomes using the instrument variable (IV) approach to tackle the endogeneity issue inherent in studying the impact of smoking to economic outcomes.

The endogeneity issue rises because individuals may smoke due to stress or lack of access to means that can support them.[59] Stress or lack of access of support may stem from weak performance in the labor market including unemployment and job loss. In addition, the individual may find it harder to find a job with less educational attainment such as a college degree. On the other hand, since smoking is societally well accepted for males, individuals who smoke may find it easier to build a social network, which is a resource in finding a job. In addition, those who work may find it easier to retain working status due to better social networks. Hence, it is not straightforward to which direction the impact of smoking to economic outcome would be. Thus, instrumenting current smoking status with past smoking status allow us to estimate the impact of smoking in the form of the cost from spending less on productive means such as education and nutrition. However, I also include the channel

[59] See for example Kouvonen et al. (2005) and Westman et al. (1985).

in which one may actually be able to build stronger social networks.

In order to control for path dependence, such as household economic condition when the respondents were young adults as well as other socio-economic confounding variables, I control for a set of variables. First, I control for current socio-economic conditions such as education attainment, marital status, urban or rural residence, and whether the individual is a head of household or not. Second, I control for socio-economic conditions when the respondents were young adults. In particular, I control for the head of household income, whether the respondents were attending school as well as rural or urban residence during young adulthood. In all specifications, I add age fixed effects and province fixed effects.

First, I find that individuals who smokes have a lower probability of possessing a college degree. Table 31 presents the estimates for smoking status for respondents who were young adults in 2000 in columns one and two, and for those who were young in 2007 in columns three and four. For both sets of respondents, the OLS estimates are biased downward. Instrumenting current smoking participation with past smoking participation results in an estimated 11 to 13% lower chance of having a college degree when the individual smokes.

Second, the impact of smoking on working status is not as conclusive. Table 32 shows the estimates for smoking status on working status in 2014. Using OLS, the estimates are not significant for both groups of respondents from survey waves in 2000 and 2007. However, instrumenting current smoking participation with past smoking participation is associated with 9% less chance of having a job for respondents who were 17 to 23 years of age in 2000. The estimates using IV approach are not significant for those who were young adults in 2007. These results are consistent with the prediction that smoking behavior, despite may cause less investment on human capital, may promote the accumulation of social capital. Thus, the impact of smoking on working status may not be straightforward.

3.5.3 Robustness analysis

I perform several robustness analyses to support the evidence of the new-consumer margin due to improvement in marketing technology represented by TV exposure. First, instead of using the relative exposure, I also use the actual average of TV exposure as the main variable of interest. Second, I include prices of cigarettes as controls. Lastly, I relax one of the selection criteria in the sample construction. In particular, instead of focusing on males who are not heads of households, I include males who are also heads of household as part of the robustness check.

The evidence of new-consumer margin due to the improvement in marketing technology prevails if we use the actual and not-standardized subdistrict-average number of TV channels received. Table 33 shows the results of running equation 41 using this measure of TV exposure on both the full sample and male-only sample. The coefficient estimate is not significant if we do not take into account the heterogenous impacts of TV exposure across age groups. However taking into account such heterogeneity, TV exposure significantly increases the chance of smoking for thee younger age group. The second column of Table 29 provides the marginal effect of TV exposure on smoking participation for the male-only sample. Increases in the number of TV broadcasting stations received is associated with higher smoking participation for those who are 17 and 19 years old.

Controlling for prices of cigarettes also do not change the results. In order to capture variation in prices, I interact real national prices of clove cigarettes with province fixed effects. If there are any time invariant trade costs, the interaction with province fixed effects can capture that. This strategy was chosen due to the unavailability of data on regional prices of cigaretters. Prices of clove cigarettes are chosen, instead of the prices of white cigarettes, as most Indonesian smokers consume clove cigarettes. Nevertheless, there is a high correlation between the prices of these two types of cigarettes as illustrated in Figure 52.

Columns three and six on Table 28 present the coefficients of interest from running the DiD estimation. We can see that there are no substantial changes in the estimated coefficients. In addition, no substantial changes in estimated coefficients can be observed in other control variables as well. Columns three and six in Table 30 provides the estimated coefficients for education and income variables, once we control for prices.

The insignificant impact on of controlling for prices is consistent with the findings in other studies, such as Adioetomo et al. (2005). They find that prices are not a significant determinant in smoking participation. Yet, prices affect the amount of tobacco consumption. In addition, Witoelar et al. (2005) also finds insignificant impact of prices to youth smoking participation. Concerning such results, Setyonaluri et al. (2008) argue that there is not much regional variation in prices of cigarettes, on top of relatively stable real prices of cigarettes in Indonesia. Hence, we may not see any significant impact of prices to smoking participation.

Lastly, the evidence of new-consumer margin also persists if we relax one of the selection criteria in the sample construction. In particular, I run equation 41 on all male-only samples of 17 to 23 years old, including those who are household heads in their households. Given this selection criteria, there are less variables in the set of individual controls. In particular, I do not control the characteristics of the proxy for parents, which is the socio-economic variables of household heads if the individu is not a household head.

Table 34 presents the marginal effect of TV exposure to smoking participation by age. Younger age groups, especially the ones with 18 and 19 years of age, have higher chance of smoking if they live in subdistricts with relatively higher TV exposure. In this setup, the impact of TV exposure to smoking participation of young adults, with age 21 to 23 years old, are not significant either. These results echo the evidence of the new-consumer margin due to improvement in marketing technology. Such margin, across several robustness checks, are especially active for adolescents.

3.6 Conclusion

Improvement in marketing technology allows firms to generate new consumers. This paper investigates this theoretical prediction, derived from the theory of marketing cost in international trade built by Arkolakis (2010). In particular, I test the prediction by estimating the impact of exposure to television, representing ads through television and other broadcasted media, on smoking prevalence among young adults in Indonesia. In general, as predicted, higher local exposure to TV generates more smokers especially the younger adults. This finding is robust across different measuremenst of TV exposure as well as sample construction.

This evidence on new-consumer margin in the form of smoking participation can inform policymakers in regulating the advertisements and marketing of tobacco products. First, the result emphasizes that the impact takes the form of new smokers. This fact stands in contrast to the argument that the purpose of tobacco advertisement is to strengthen branding, i.e., advertisements only affect the smoking intensity or the intensive margin of tobacco consumption. Indeed, despite the relatively limited hours of allowance for tobacco ads to be broadcasted, I find a statistically significant impact in increasing smoking participation in young adults. Second, I also show that smoking is associated with worse performance in the labor market. Given that exposure to advertising entices smoking participation to especially younger adults, the worse performance of this productive labor force in the labor markets, in the long run, can create a bigger cost to the economy. This economic cost is on top of the high cost of burden of disease of smoking. Third, despite the declining global smoking prevalence, as many developing economies have a higher share of the young population, advertising efforts of tobacco companies in such economies would have bigger macro consequences.

Appendix 3

Tables

Table 22: Percentages of average per capita monthly expenditure by commodity groups

Commodity group	2000		2010		2015	
	urban	rural	urban	rural	urban	rural
Rice and other cereals	11.97	20.89	6.24	13.07	5.53	11.59
Tobacco products	5.67	8.29	4.39	6.61	5.12	8.40
Education costs	4.89	2.11	4.38	2.48	4.59	2.77
Health costs	2.10	1.76	2.79	2.47	3.36	3.17

Source: Statistik Indonesia 2001, 2011, and 2016.

Table 23: Smoking prevalence by age group and sex in 1995, 2001, 2004

Age	1995			2001			2004		
group	males	females	average	males	females	average	males	females	average
10-14	0.5	0.1	0.3	0.7	0.0	0.4	na	na	na
15-19	13.7	0.3	7.1	24.2	0.2	12.7	32.8	1.9	17.3
20-24	42.6	1.0	20.3	60.1	0.6	28.8	63.6	4.1	30.6
25-29	57.3	1.1	27.4	69.9	0.6	33.7	69.9	4.5	34.7
30-34	64.4	1.2	31.5	70.5	0.9	35.3	68.9	3.8	37.3
35-39	67.3	1.7	35.6	73.5	1.3	36.6	67.7	5.0	39.7
40-44	67.3	2.3	34.2	74.3	1.9	39.6	66.9	4.9	40.1
45-49	68.0	3.1	35.7	74.4	2.2	41.3	67.9	5.8	41.0
50-54	66.8	3.4	34.5	70.4	2.6	34.8	67.9	4.9	38.8
55-59	66.1	3.3	33.9	69.9	3.0	36.3	64.1	6.2	36.8
60-64	64.7	2.8	32.2	65.6	2.8	32.6	60.0	6.2	31.3
65-69	64.3	3.8	34.0	64.7	2.7	32.2	58.7	4.4	30.9
70-74	56.9	3.1	30.6	59.2	2.1	30.0	55.3	3.8	27.0
75+	53.3	1.9	24.8	48.5	2.1	23.5	47.4	4.1	24.9
Average	53.4	1.7	27.0	62.2	1.3	31.5	63.1	4.5	34.4

Source: Susenas 1995, 2001, 2004, calculated and presented as Table 2.2 and Annex 2.1 by Setyonaluri et al. (2008).
Notes: Aceh and Maluku not included in 2001. Respondents in 2004 were 15 years and older.

Table 24: Market shares of main tobacco companies in global cigarette market

Tobacco companies	share of world cigarette volume (%)
Chinese National Tobacco Company	43.2
Philip Morris International	14.3
British American Tobacco	11.6
Japan Tobacco International	9.4
Imperial Tobacco	4.9

Source: Euromonitor, compiled and presented as "Table: The global tobacco industry (2013 data)" by Gilmore et al. (2015).
Notes: Data for 2013.

Table 25: Number of tobacco manufacturers in Indonesia by foreign ownership status

Year	domestic firms	foreign ownership	
		any foreign ownership	more than 50% ownership
1990	955	6	2
1995	808	7	6
2000	799	5	3
2005	850	8	6
2010	973	8	7

Source: Manufacturing Survey 1990, 1995, 2000, 2005, 2010. Author's calculation.
Notes: Domestic firms are firms with zero foreign ownership.

Table 26: Coefficients of production function

Variable	AK		Updated AK		
	OLS	OP	OP 1	OP 2	OP 3
Labor	0.159	0.105	0.150	0.150	0.150
Materials	0.875	0.875	0.907	0.907	0.907
Capital	0.036	0.000	0.040	0.028	0.034
Period	1991-2001	1991-2001	1990-2012	1990-2012	1990-2012
Exporter FE	X	X	X	X	X
Importer FE	X	X	X	X	X
Crisis FE	X	X	X	X	X
Foreign-ownership FE			X	X	X
Optimization method			BFGS	NM	DFP

Notes: Production function is assumed to be Cobb-Douglas production function as shown by equation 42. OLS refers to ordinary-least square method in estimating the coefficients. Meanwhile, OP refers to the Olley-Pakes method in estimating production function as in Olley and Pakes (1992). The estimated coefficients of production fuction for AK are taken from Table 2 in Amiti and Konings (2007) for the tobacco industry. BFGS refers to Broyden-Fletcher-Goldfarb-Shanno optimization, NM refers to Nelder-Mead optimization, and DFP refers to Davidon-Fletcher-Powell optimization.

Table 27: Balance table

Variable	(1) 2000 Mean/SE	(2) 2007 Mean/SE	T-test Difference (1)-(2)
Smoking	0.271	0.249	0.022**
	(0.006)	(0.007)	
Male	0.445	0.415	0.029***
	(0.007)	(0.008)	
Age	19.784	20.038	-0.254***
	(0.029)	(0.032)	
Education	7.190	7.035	0.154
	(0.061)	(0.072)	
Attending school	0.242	0.213	0.029***
	(0.006)	(0.006)	
Working	0.396	0.401	-0.005
	(0.007)	(0.008)	
Married	0.277	0.337	-0.060***
	(0.007)	(0.007)	
Urban	0.533	0.519	0.013
	(0.007)	(0.008)	
HH head, smoking	0.514	0.548	-0.034***
	(0.007)	(0.008)	
HH head, education	4.399	4.760	-0.361***
	(0.061)	(0.067)	
HH head, real annual income	1.28e+05	2.83e+05	-1.55e+05
	(43384.549)	(1.09e+05)	
HH head, male	0.881	0.872	0.009
	(0.005)	(0.005)	
HH head, working	0.705	0.746	-0.040***
	(0.007)	(0.007)	
HH head, married	0.721	0.754	-0.034***
	(0.007)	(0.007)	
N	4733	4142	
F-test of joint significance (F-stat)			7.246***
F-test, number of observations			8875

Notes: The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. Standard errors are robust. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table 28: Dependent var: smoking

	(1)	(2)	(3)	(4)	(5)	(6)
TV channels, std	0.003	0.018	0.018	0.016	0.037*	0.037*
	(0.008)	(0.012)	(0.012)	(0.013)	(0.023)	(0.023)
age=18 x TV		-0.001	-0.001		0.012	0.012
		(0.017)	(0.017)		(0.030)	(0.030)
age=19 x TV		-0.007	-0.007		0.018	0.018
		(0.019)	(0.019)		(0.032)	(0.032)
age=20 x TV		-0.007	-0.007		-0.043	-0.043
		(0.019)	(0.019)		(0.033)	(0.033)
age=21 x TV		-0.033*	-0.033*		-0.065**	-0.065**
		(0.018)	(0.018)		(0.031)	(0.031)
age=22 x TV		-0.039**	-0.039**		-0.062*	-0.062*
		(0.019)	(0.019)		(0.032)	(0.032)
age=23 x TV		-0.027	-0.027		-0.044	-0.044
		(0.018)	(0.018)		(0.033)	(0.033)
N	8251	8251	8251	3557	3557	3557
Sample	all	all	all	male	male	male
Province x Wave	X	X	X	X	X	X
Price x Province			X			X

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Full sample includes inviduals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are not household heads. Number of TV channels is the subdistrict average of number of TV channels. This variable is standardized to have zero mean and a standard variation of one in each survey year. In column 2, 3, 5, and 6, the coefficient of "TV channels, std" refers to the coefficient for the interaction between TV exposure and age group of 17 years old which is the base group. The coefficient for the interaction between TV exposure and age groups for age 18 to 23 are relative to the coefficient for the TV exposure and the age group for 17 years old. All specifications include age fixed effects, province fixed effects, and survey wave fixed effects. Robust standard errors are used.

Table 29: Marginal effect of exposure to televisions on smoking participation in 17-23 years old

	Slope TV channels, std	TV channels
main		
age = 17	0.037*	0.012*
	(0.023)	(0.006)
age = 18	0.049**	0.011
	(0.025)	(0.007)
age = 19	0.056**	0.013*
	(0.027)	(0.007)
age = 20	-0.005	0.001
	(0.028)	(0.007)
age = 21	-0.028	-0.000
	(0.025)	(0.007)
age = 22	-0.024	-0.005
	(0.027)	(0.008)
age = 23	-0.007	-0.001
	(0.028)	(0.007)
Observations	3557	3557

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Sample includes inviduals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are males and not household heads. Number of TV channels is the subdistrict average of number of TV channels. In the first column, this variable is standardized to have zero mean and a standard variation of one in each survey year. Meanwhile, in the second column, the variable of TV channels is the actual subdistrict averages. Slope refers to the changes in the probability of smoking participation for an increase of one standard deviation in exposure to televisions in the first column and of one unit of extra TV channels received in the second column. The specification includes age fixed effects, province fixed effects, survey wave fixed effects, and province and survey wave fixed effects. Robust standard errors are used.

Table 30: Estimates for education and income

	(1)	(2)	(3)	(4)	(5)	(6)
Education	0.001	0.001	0.001	-0.005**	-0.005**	-0.005**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
HH head, education	-0.008***	-0.008***	-0.008***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
HH head, income	-0.000**	-0.000**	-0.000**	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	8251	8251	8251	3557	3557	3557
Sample	all	all	all	male	male	all
TV x Age		X	X		X	X
Province x Wave	X	X	X	X	X	X
Price x Province			X		X	X

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Sample includes inviduals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are not household heads. All specifications include age fixed effects, province fixed effects, and survey wave fixed effects. Robust standard errors are used.

Table 31: Long-run economic impacts of smoking: college degree

	(1)	(2)	(3)	(4)
Smoking	-0.089***	-0.128**	-0.076***	-0.112***
	(0.025)	(0.051)	(0.024)	(0.040)
N	1208	1208	1147	1147
Wave	2000	2000	2007	2007
Model	OLS	IV	OLS	IV

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Sample includes individuals of 17 to 23 years old in IFLS suveys in 2000 and 2007 who are male and not household heads. The dependent variable is whether the individu has a college degree as reported in IFLS survey in 2014. Regressions are run separately for each group of sample based on survey waves. OLS refers to regression using ordinary-least squares while IV refers to instrumenting smoking status in 2014 with smoking status in year 2000 or 2007, i.e. when the individu was 17 to 23 years old. All specifications include age fixed effects and province fixed effects. Robust standard errors are used.

Table 32: Long-run economic impacts of smoking: working status

	(1)	(2)	(3)	(4)
Smoking	-0.016	-0.088**	-0.015	-0.045
	(0.019)	(0.040)	(0.024)	(0.040)
N	1208	1208	1147	1147
Wave	2000	2000	2007	2007
Model	OLS	IV	OLS	IV

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Sample includes individuals of 17 to 23 years old in IFLS suveys in 2000 and 2007 who are male and not household heads. The dependent variable is the individu's working status reported in IFLS survey in 2014. Regressions are run separately for each group of sample based on survey waves. OLS refers to regression using ordinary-least squares while IV refers to instrumenting smoking status in 2014 with smoking status in year 2000 or 2007, i.e. when the individu was 17 to 23 years old. All specifications include age fixed effects and province fixed effects. Robust standard errors are used.

Table 33: Robustness analysis using average TV channels received, dependent variable: smoking

	(1)	(2)	(3)	(4)	(5)	(6)
TV channels	0.002	0.006*	0.006*	0.005	0.012*	0.012*
	(0.002)	(0.003)	(0.003)	(0.004)	(0.006)	(0.006)
age=18 x TV		-0.001	-0.001		-0.001	-0.001
		(0.005)	(0.005)		(0.008)	(0.008)
age=19 x TV		-0.003	-0.003		0.001	0.001
		(0.005)	(0.005)		(0.008)	(0.008)
age=20 x TV		-0.003	-0.003		-0.011	-0.011
		(0.005)	(0.005)		(0.009)	(0.009)
age=21 x TV		-0.007	-0.007		-0.012	-0.012
		(0.005)	(0.005)		(0.008)	(0.008)
age=22 x TV		-0.013***	-0.013***		-0.017*	-0.017*
		(0.005)	(0.005)		(0.009)	(0.009)
age=23 x TV		-0.006	-0.006		-0.013	-0.013
		(0.005)	(0.005)		(0.009)	(0.009)
N	8251	8251	8251	3557	3557	3557
Sample	all	all	all	male	male	male
Province x Wave	X	X	X	X	X	X
Price x Province			X			X

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Full sample includes inviduals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are not household heads. Number of TV channels is the subdistrict average of number of TV channels. In column 2, 3, 5, and 6, the coefficient of "TV channels" refers to the coefficient for the interaction between TV exposure and age group of 17 years old which is the base group. The coefficient for the interaction between TV exposure and age groups for age 18 to 23 are relative to the coefficient for the TV exposure and the age group for 17 years old. All specifications include age fixed effects, province fixed effects, and survey wave fixed effects. Robust standard errors are used.

Table 34: Robustness analysis with household heads in the sample, dependent variable: smoking

	Slope
TV channels, std	
age = 17	0.031
	(0.022)
age = 18	0.049**
	(0.024)
age = 19	0.053**
	(0.025)
age = 20	-0.010
	(0.024)
age = 21	-0.031
	(0.022)
age = 22	-0.001
	(0.024)
age = 23	-0.000
	(0.023)
Observations	4342

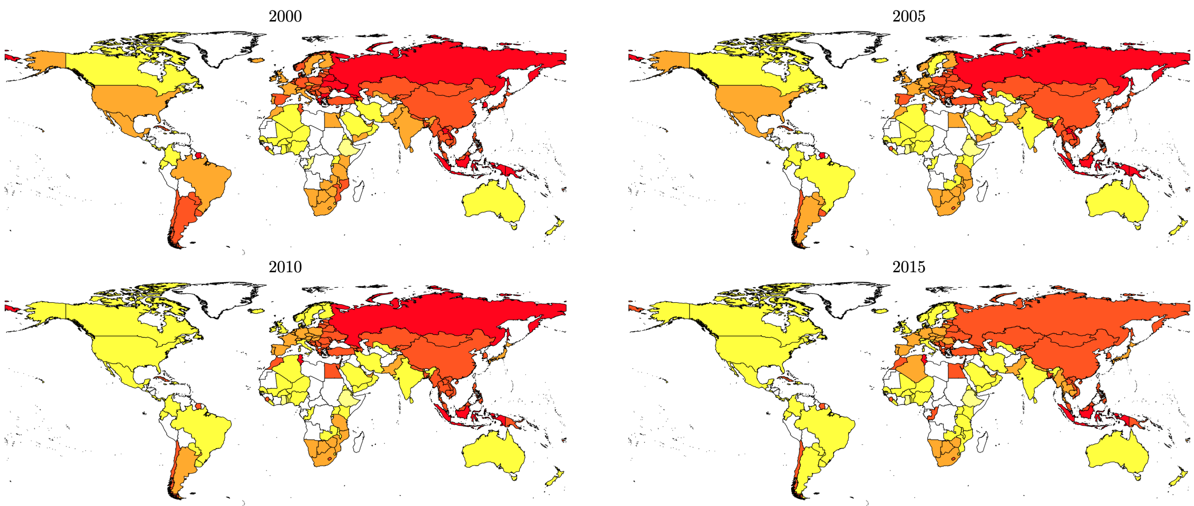
Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Sample includes invividuals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are males. Number of TV channels is the subdistrict average of number of TV channels. This variable is standardized to have zero mean and a standard variation of one in each survey year. Slope refers to the changes in the probability of smoking participation for an increase of one standard deviation in exposure to televisions. The specification includes age fixed effects, province fixed effects, survey wave fixed effects, and province and survey wave fixed effects. Robust standard errors are used.

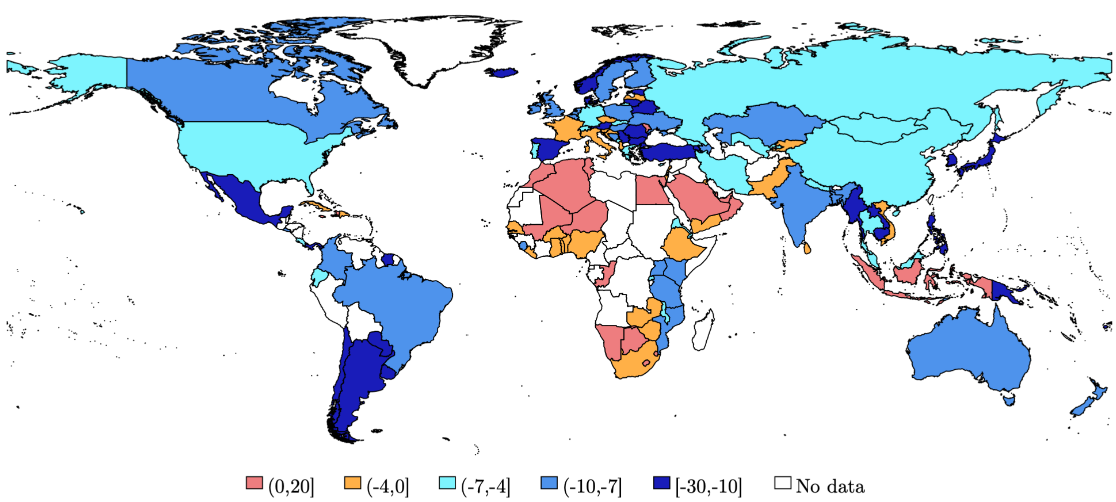
Figures

Figure 42: Global smoking prevalence over time (% of adult male)



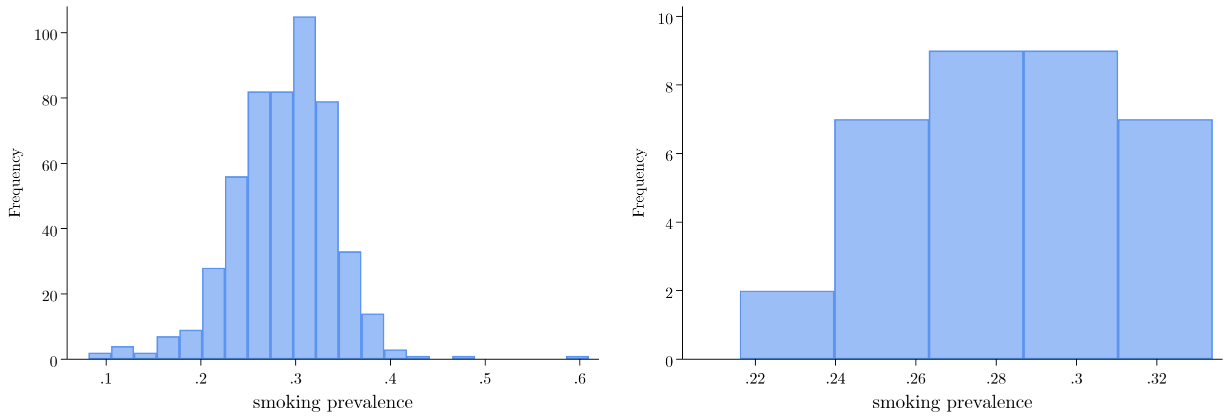
Source: WHO.
Notes: The maps show the smoking prevalence for adult males. The cutoffs are from yellow to red: [0, 10], (10, 30], (30, 40], (40, 60], (60, 100]. Yellow colors represent lower smoking rates while red colors represent higher smoking rates.

Figure 43: Percentage point changes in adult male smoking prevalence 2000-2015



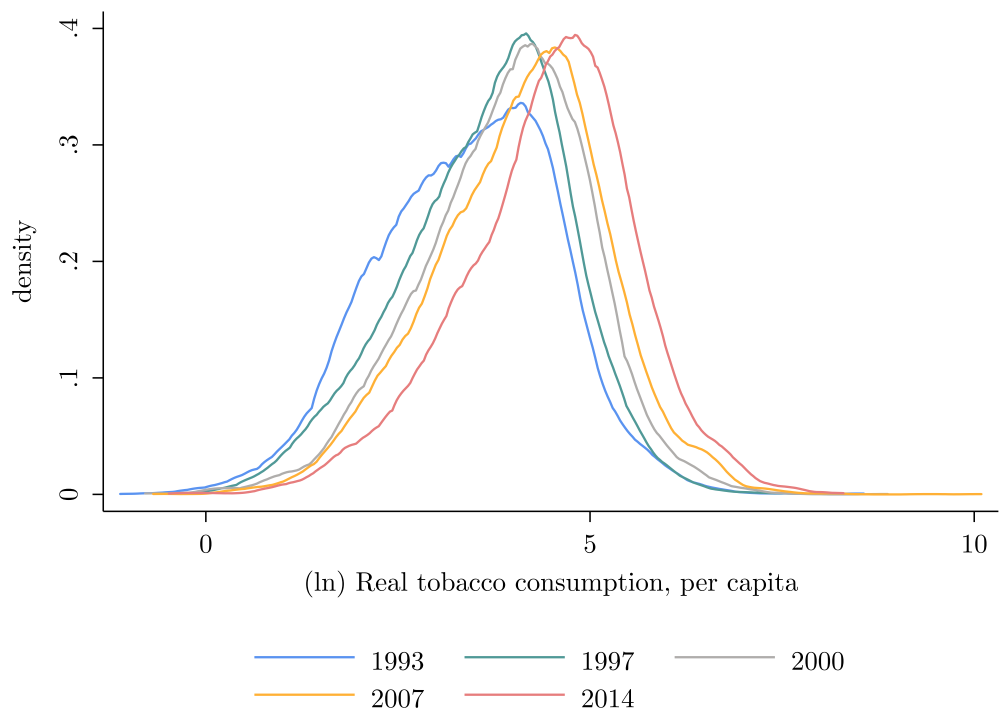
Source: WHO, author's calculation.
Notes: Please note that the color ranges are not equal. Countries with increases in rates of smoking prevalence are in pink.

Figure 44: Smoking prevalence by district (left) and province (right) in 2016



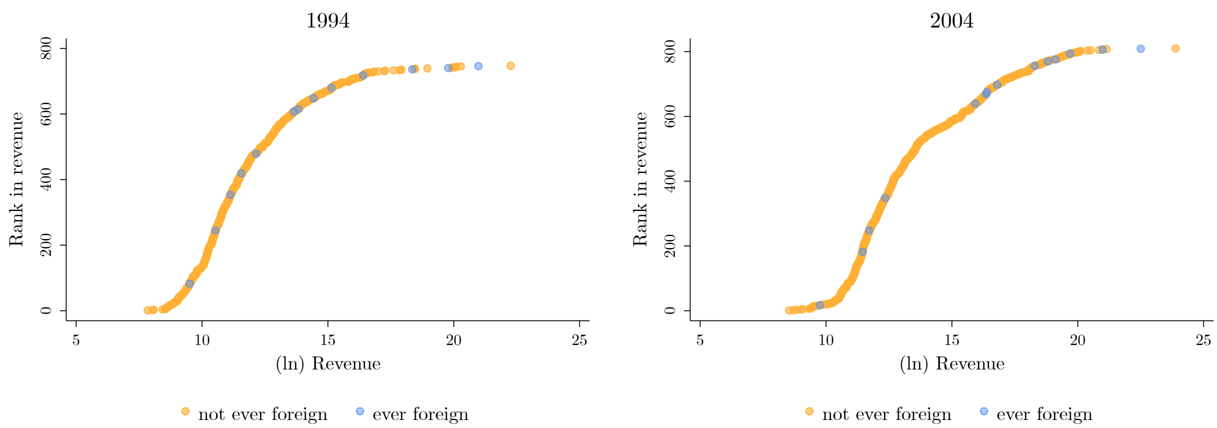
Source: Susenas 2016, author's calculation.
Notes: Smoking prevalence for population of 15 years or older.

Figure 45: Per capita real consumption on tobacco products



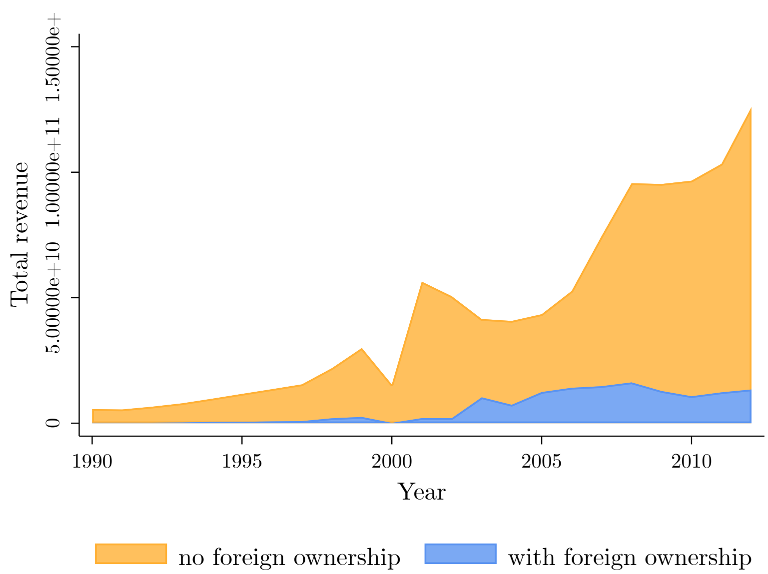
Source: IFLS and Indonesia's CPI, author's calculation.

Figure 46: Size and rank of firms by revenue in 1994 (left) and 2004 (right)



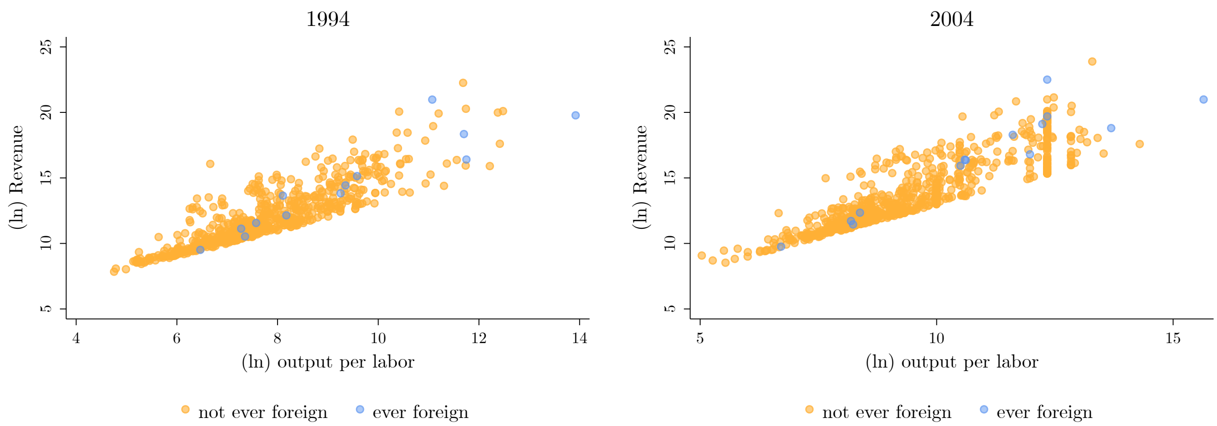
Source: Manufacture survey, author's calculation.

Figure 47: Production of Indonesian tobbacco manufacturers



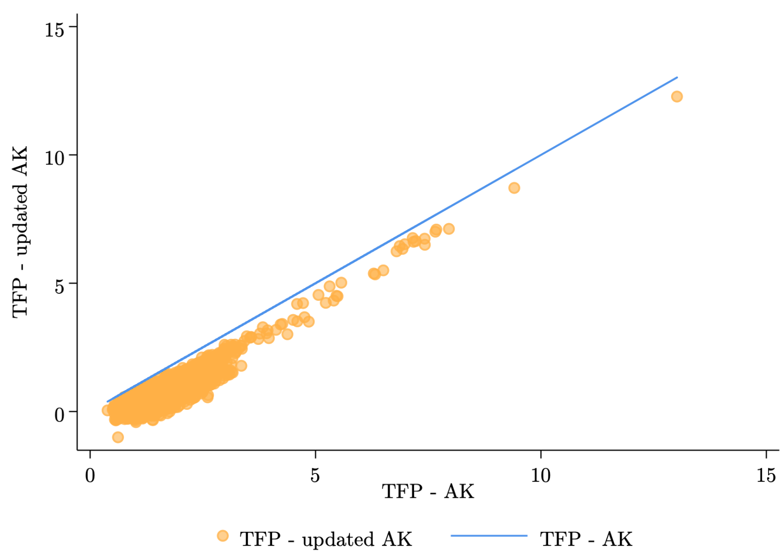
Source: Manufacture survey, author's calculation.

Figure 48: Output per labor and revenue in 1994 (left) and in 2004 (right)



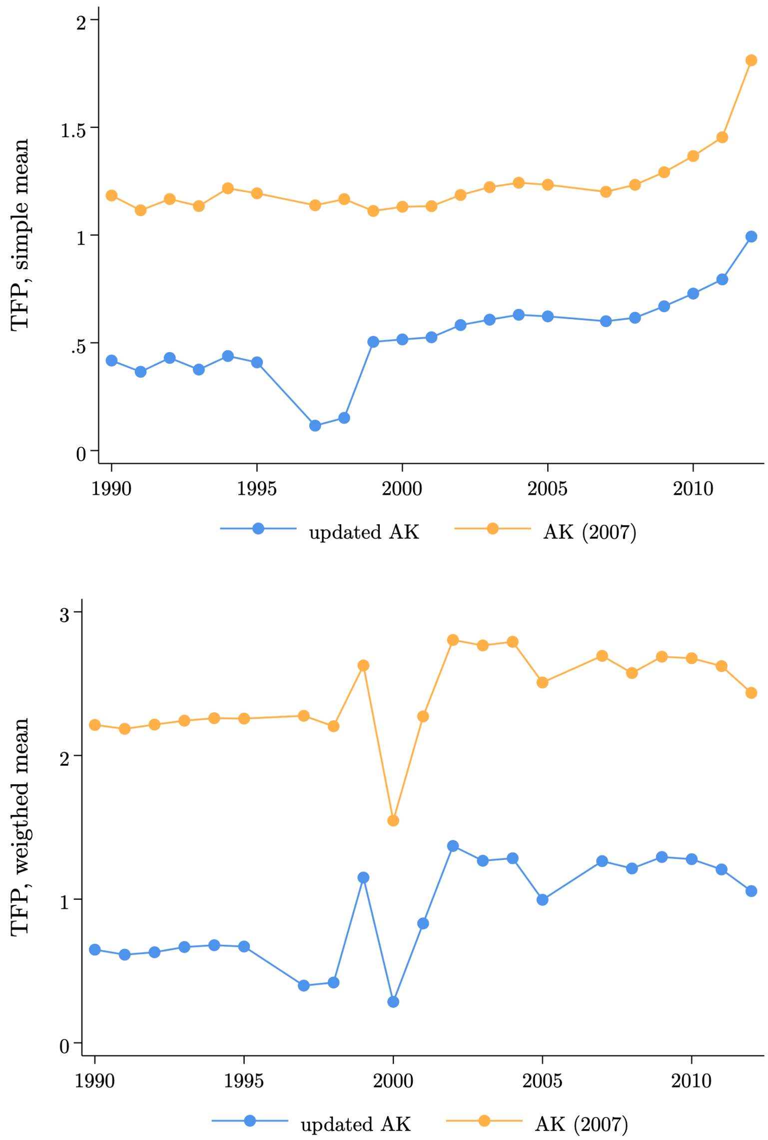
Source: Manufacture Survey, author's calculation.

Figure 49: Comparison of estimated TFP



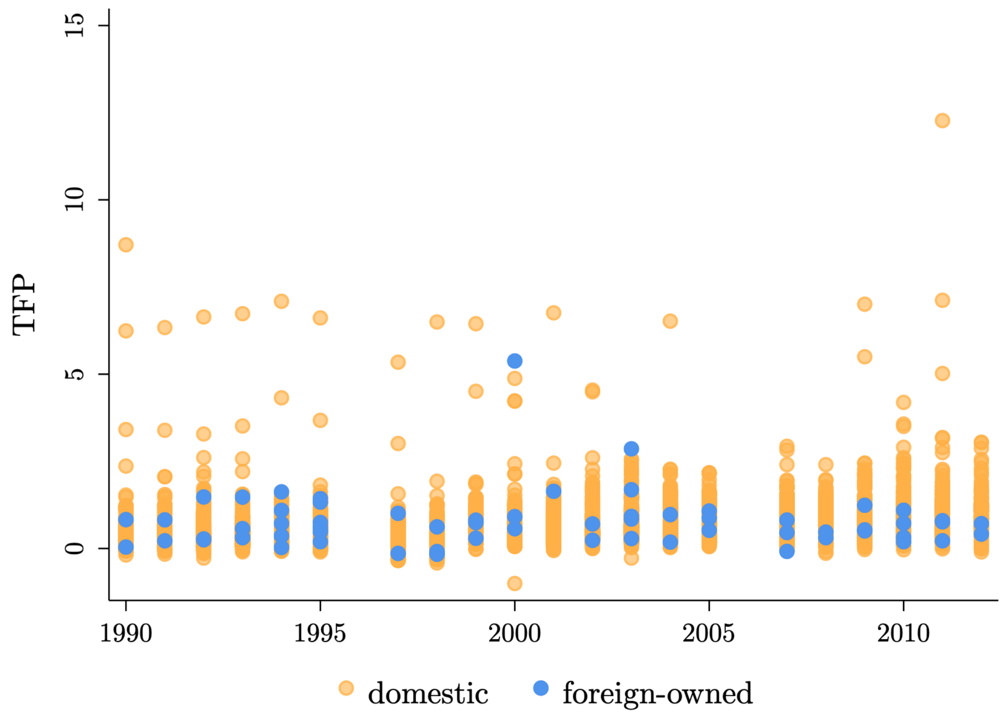
Notes: Each unit is estimated TFP for firm i in year t. Sample period is 1990 to 2012. Estimated TFP labelled "TFP - Updated AK" refers to the estimated TFP using the coefficients of production function from column "OP 1" on Table 26. Meanwhile, estimated TFP labeled "TFP - AK (2007)" refers to estimated TFP using the coefficients of production from column "OP" on Table 26 as calculated by Amiti and Konings (2007) for the tobacco industry.

Figure 50: Industry-average TFP



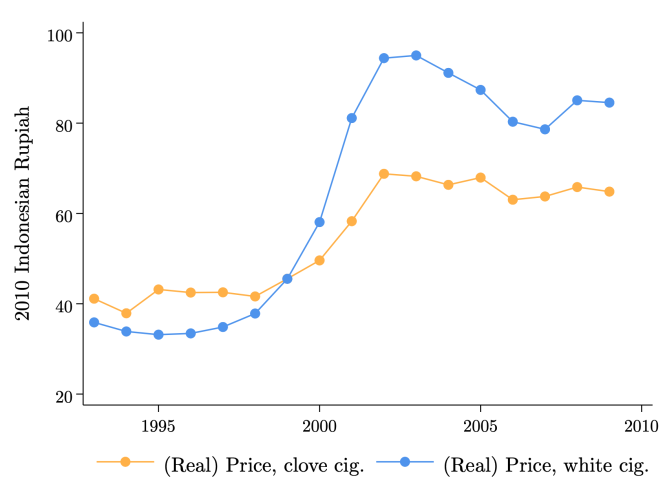
Source: Manufacture Survey and Table 26, author's calculation.
Notes: Estimated TFP for AK (2007) uses the estimated production function for tobacco industry performed by Amiti and Konings (2007). Meanwhile, estimated TFP for updated AK uses the estimated production function using the Broyden-Fletcher-Goldfarb-Shanno optimization as shown by Table 26. For weighted averages, I use gross output as weights.

Figure 51: Estimated TFP by foreign ownership over time



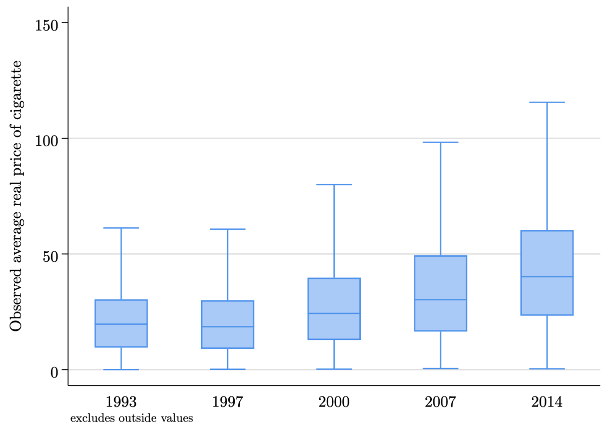
Source: Manufacture survey and coefficients from column "OP 1" on Table 26, author's calculation.
Notes: Each unit is estimated TFP for firm i in year t. Sample period is 1990 to 2012. Firms with any non-zero foreign ownership are colored in blue.

Figure 52: Real prices of cigarettes



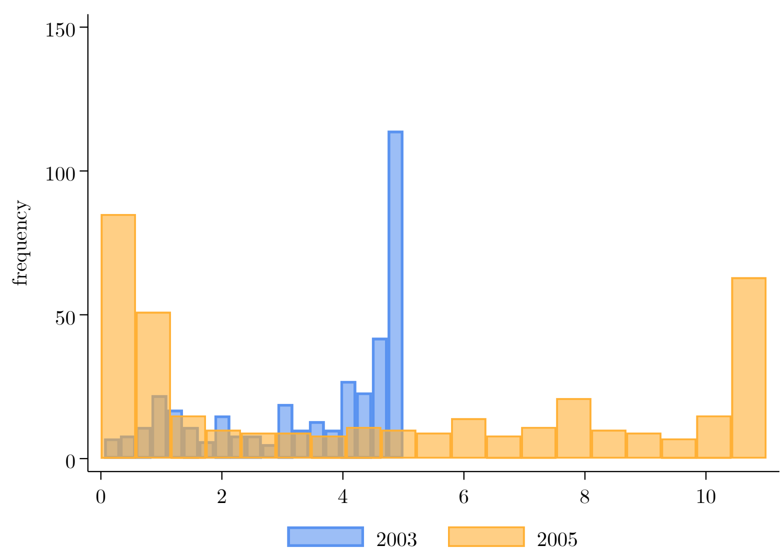
Source: Statistik Indonesia, author's calculation.

Figure 53: Observed real price of cigarettes spent by households



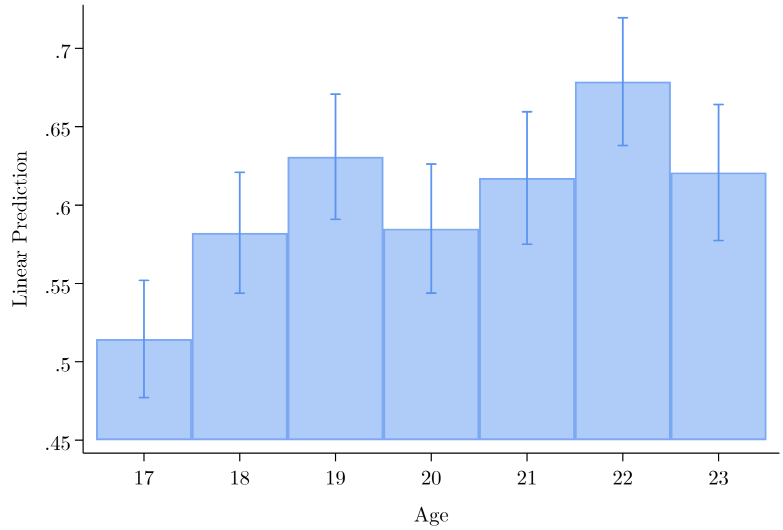
Source: Indonesia Family Life Surveys, author's calculation.

Figure 54: Variation in number of TV channels across districts



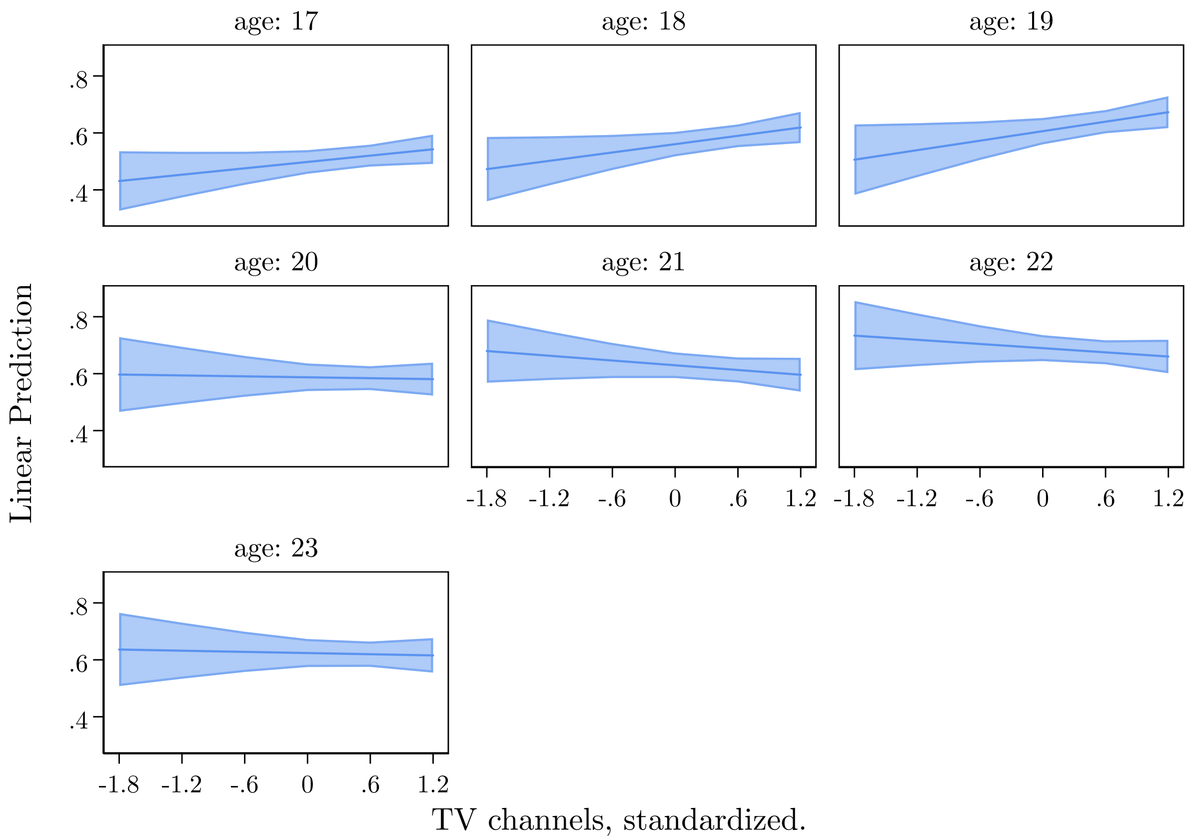
Source: Village Census 2003 and 2006, author's calculation.
Notes: Number of TV channels is the district average of number of TV channels received in villages within a district.

Figure 55: Coefficient estimates for age fixed effects to smoking participation in 17-23 years old



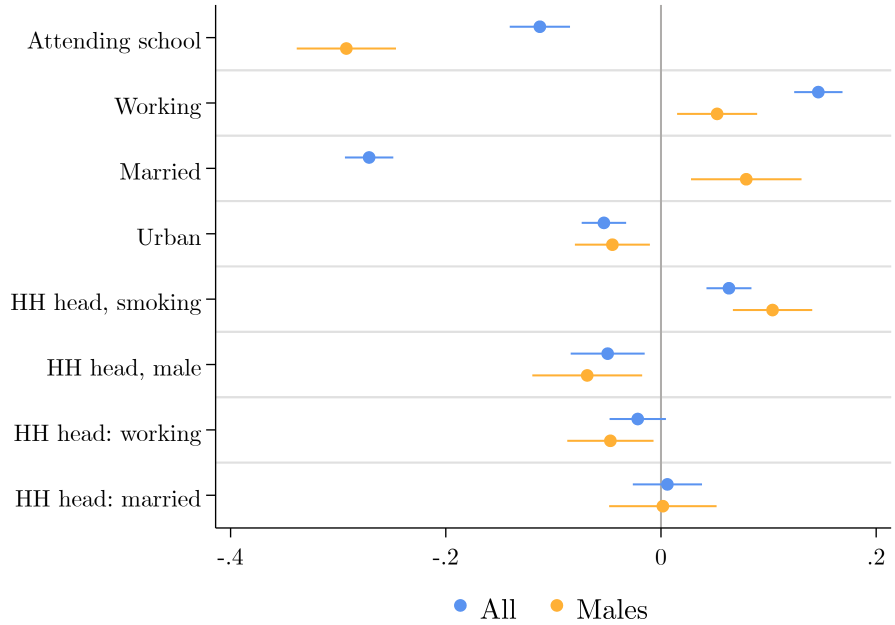
Notes: Sample includes inviduals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are males and not household heads. The ranges show the 95% confidence interval of the estimated coefficients. The specification includes age fixed effects, province fixed effects, survey wave fixed effects, and province and survey wave fixed effects. Robust standard errors are used.

Figure 56: Effects of TV exposure by age group



Notes: Dependent variable is smoking status to sample of 17-23 years old who are male and not household heads. Sample includes inviduals of 17 to 23 years old in IFLS surveys in 2000 and 2007 who are males and not household heads. The ranges represents the 95% confidence interval of the estimated impact of exposure to TV to smoking participation. The specification includes age fixed effects, province fixed effects, survey wave fixed effects, and province and survey wave fixed effects. Robust standard errors are used.

Figure 57: Estimates of control variables on smoking



Notes: Dependent variable is smoking status to sample of 17-23 years old who are not household heads. The range represents the 95% confidence interval. All specifications include age fixed effects, province fixed effects, survey wave fixed effects, and province and survey wave fixed effects. The 95% confidence intervals for coefficients are shown by the range plots. All specifications use robust standard errors.

Data Appendix: Estimating Total Factor Productivity

In order to estimate firm-level total factor productivity (TFP), I replicate the estimation strategy conducted by Amiti and Konings (2007), or henceforth AK. They estimate TFP using the same dataset with the one that I use to analyze the tobacco industry in Indonesia, i.e., the Indonesian Manufacturing Survey. AK analyzed thee TFP trend for the period between 1991 to 2001 for each three-digit industry classification. AK used the Olley-Pakes method and assumed that there are fixed costs in exporting and importing, as in Melitz (2003). AK also took into account the effect of the Asian Financial Crisis in from 1997-1998 by including fixed effects for crisis. I follow AK's strategy and add fixed costs of being a foreign affiliates as in Helpman et al. (2004).

Let us assume that each firm i in year t operates with a Cobb-Douglas production function as shown in equation 42 below. In producing output Y_{it}, each firm combines several factors of production: capital (K), labor (L), and materials (M). The firm's level of productivity is A_{it}.

$$Y_{it} = A_{it} L_{it}^{\beta_l} K_{it}^{\beta_k} M_{it}^{\beta_m} \tag{42}$$

I follow AK in performing the method introduced by Olley and Pakes (1992) in estimating the production function. In particular, I estimate the log-linearized production function as shown by equation 43, where $x = ln(X)$, for each variable. TFP of firm i of industry k in year t is then computed as the difference between its observed output, y_{it}, and its estimated output as shown in equation 44.

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \epsilon_{it} \tag{43}$$

$$tfp_{it}^k = y_{it} - \hat{\beta_l} l_{it} - \hat{\beta_k} k_{it} - \hat{\beta_m} m_{it} \tag{44}$$

Table 26 compares the estimated coefficients of each factors of production with the coefficients estimated by AK for the tobacco industry.[60] These coefficients are relatively comparable across different types of optimization methods. Figure 49 also confirms the comparability between the estimated TFP using AK's coefficients and the estimated TFP using updated AK's coefficients. I select the Broyden-Fletcher-Goldfarb-Shanno optimization method as the basis of estimated TFP throughout the paper.

[60] I follow the suggestions from Márquez-Ramos (2020) in taking into account attrition in Manufacturing Survey data and suggestions from Amiti and Konings (2007) in checking the consistency across the sample period to improve confidence on the results.

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